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INDUSTRIAL QUALITY CONTROL

QUALITY through Scientific Methods

Prof. Mason E. Wescott

Prof. Irving W. Burr

JOURNAL OF THE AMERICAN SOCIETY FOR QUALITY CONTROL

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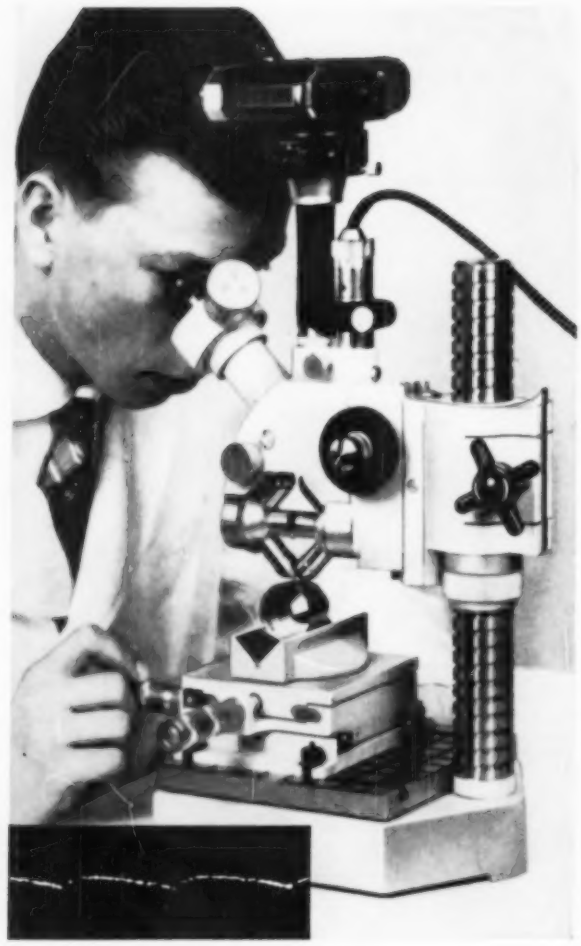
WEST GERMANY

LIGHT SECTION MICROSCOPE



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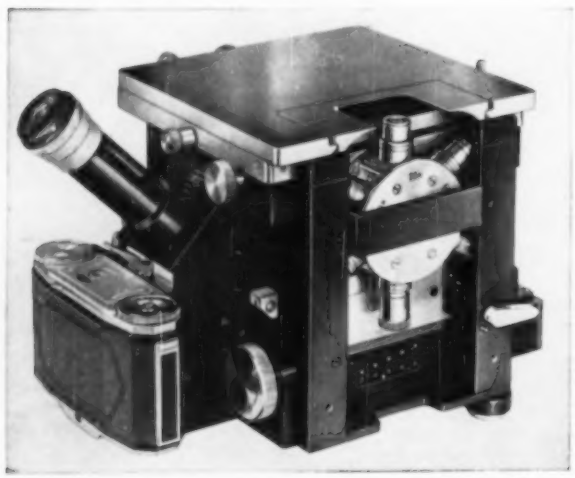

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INDUSTRIAL QUALITY CONTROL

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The Constancy of Change

On July 1, 1961 *Industrial Quality Control* passed another milestone in its history. On that date Prof. Mason E. Wescott officially retired as Chairman of the Editorial Board and Prof. Irving W. Burr became the Society's new Editorial Chairman. Although the official transfer took place on July 1, Professors Wescott and Burr have been working together for the past year to effect a smooth transition in the operations of IQC. To further implement this transition Prof. Wescott will serve out the remainder of Prof. Burr's term on the Editorial Board.

Prof. Wescott retired as Editorial Chairman after fourteen years of service to the Society, having accepted appointment to the post in 1947. He was honored by the Society at the Annual Banquet on June 6th with the presentation of a Special Resolution of the Board of Directors.

After receiving his BS and MS in mathematics from Northwestern University Prof. Wescott received his PhD from Northwestern in 1939. He stayed on as an assistant professor of mathematics at Northwestern until 1952, when he moved to his present position of professor of applied statistics at Rutgers University.

In that same year from September 1952 through February 1953 he served as a member of the four man team that was sent to India by the Technical Assistance Administration of the United Nations to teach and promote quality control techniques in Indian industry.

Prof. Wescott is well-known as one of the pioneers of statistical quality control. He has been active in consulting and in-plant training courses and has participated as a member of the staff in innumerable quality control short courses offered annually by various colleges and universities. In addition to his service as Chairman of the Editorial Board, Prof. Wescott has served the Society in many other areas during these fourteen years. While it's impossible to list all the committees on which he has served during this time, an indication of the magnitude is apparent from the present group of which he is a member: Bibliography and Library, Brumbaugh Award, Convention Program, Publications, Saddoris Award and Shewhart Medal. But over and beyond these perhaps his greatest service to ASQC has been the calm approach and very acute insight he has brought to the Operating and Executive Committee meetings of the Society.

Prof. Wescott was elected a Fellow of the Society in 1948 and was selected as the Shewhart Medalist for 1956. He is also a Fellow of the American Statistical Association; a member of the Institute of Mathematical Statistics, Phi Beta Kappa and Sigma Xi.

With Prof. Wescott's resignation, Prof. Burr becomes the Society's third Editorial Chairman. Martin A. Brumbaugh, founder of IQC in 1944, became the Society's first chairman when ASQC was founded in 1946.

Like Prof. Wescott, Prof. Burr is also well qualified for the post. He was graduated from Antioch College with a BS in 1930 and during the 30's remained at Antioch as an instructor and associate professor of mathematics. He received his MS from the University of Chicago in 1935 and his PhD in mathematical statistics from the University of Michigan in 1941. At this time he joined the staff of Purdue University as an assistant professor of mathematics. He is currently a professor of mathematics and statistics of the Statistical Laboratory at Purdue.

Prof. Burr too is well-known as one of the early pioneers in SQC. He developed and taught the first undergraduate credit course in applied statistics for engineers at Purdue and subsequently, in 1947, he introduced the first advanced 8-day SQC course. This course was unique because it dealt with topics beyond those normally covered in the basic courses. Prof. Burr first became associated with the SQC short courses 1943 when he attended an OPRD 8-day training course at the Illinois Institute of Technology. The following year he participated in a special course at Purdue for training instructors for the OPRD courses and in 1945 he joined the OPRD course staff under Holbrook Working and Edwin G. Olds at Carnegie Tech. Like Prof. Wescott, Prof. Burr has since participated in innumerable annual short courses, including those offered by Purdue.

In terms of service to ASQC, few have been more active than Prof. Burr. He started as a Founding Member of the Society in 1946 and served as a member of its first Editorial Board. During the period that Prof. Wescott was in India, he served as acting editorial chairman. He was also a member of the first financial advisory committee and currently, in addition to serving on the Editorial Board, he is also a member of the Shewhart Medal and Standards Committees.

He has been honored by the Society on several occasions. He was elected to the grade of Fellow in 1946 and was recipient of the Brumbaugh Award for 1951 and the Shewhart Medal for 1958. Prof. Burr is also a member of the Institute of Mathematical Statistics and a Fellow of the American Statistical Association. In this latter capacity he serves as one of the three ASA representatives on the *Technometrics* Management Committee.

While the Board of Directors accepted with considerable reluctance and regret Prof. Wescott's resignation as Editorial Chairman, the Society looks forward to the benefit of his continued good counsel in other areas. Prof. Burr, who now assumes this post, is indeed most able and experienced. The Society is extremely fortunate in having such a capable man to direct the policies of its journal and welcomes him with confidence to the important post of Editorial Chairman.

With this "changing of the guard" the old quality control adage is once again verified: "There is nothing so constant as change."

June 28, 1961
Milwaukee, Wis.

G. R. Foster
Managing Editor

AN INTRODUCTION TO

THE USE OF STATISTICAL METHODS IN INDUSTRIAL EXPERIMENTATION

P. F. WADE

*Aluminum Company of Canada, Ltd.,**

Kingston, Ontario, Canada

ONE COMPANY EXECUTIVE has estimated that less than one-half of the experiments carried out in his plant lead to reports of any value.

Plant experiments can require a substantial part of a company's budget. Often the return is unbelievably low. In an attempt to improve the situation, many firms are promoting the use of statistics in their technical and engineering departments by adding statisticians to their organization or by sending personnel to "short" courses.

Like any other new and technical field, statistics requires a thorough selling job. Management support is essential to create the atmosphere which makes statistical planning and analysis not only acceptable but desirable. A complicating factor is the nature of the relationship between the experimenter and the statistician. This has been discussed by several writers.[1,2,3]

Statistical techniques cannot, of course, solve all the problems which are connected with experimenting, but they can make a valuable contribution—as the following examples may show. The steps involved in planning and analyzing an experiment have been set down in much detail,[4,5] so they will not be considered here. Instead, three case histories will be presented. For each problem, a statistical and a non-statistical approach will be compared.

Case History No. 1— The "Comparison" Type of Experiment

Problem: A customer has asked for extrusions with a guaranteed minimum tensile strength which is 1,500 psi higher than the present specification for alloy A. Another supplier has claimed it can provide such material, and a large order hangs in the balance. A program must be designed to see if modified alloy B gives the required increase in properties. For a brief description of the process, see Fig. 1.

Approach Used by Engineer

Since there is a large run-to-run variation at the extrusion press, both alloys will be compared on the same run.

Take five billets from a cast (furnace load) of alloy A and five billets from a cast of alloy B

Extrude as follows: A,A,A,A,A B,B,B,B,B

Take one test specimen from each extruded length

Compare results, see Table I

Conclude that alloy B is higher in tensile strength by 1,633 psi. The customer's order can be safely accepted.

Statistical Approach

Design: Before the experiment can be designed, the past history of cast-to-cast variations for alloys of this type must be examined. See Table II. Here it is clear that large differences can be present from one cast to another of the "same" alloy.

The following questions must now be answered:

What is the minimum increase in properties which the customer would accept "in a pinch"? *Possible answer:* 1,000 psi

What are the consequences of concluding that alloy B does not give the desired increase in properties when in reality an increase of 1,500 psi or larger does exist? (Type A error.) *Possible Answer:* More work will be done to produce suitable material. This would be unfortunate but not as undesirable as the next error.

What are the consequences of concluding that alloy B gives a worthwhile increase in properties, when in reality the increase is less than 1,000 psi? (Type B error.) *Possible Answer:* We will accept the order and find out too late

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*Mr. Wade has since joined the Management Consulting Services branch of Price Waterhouse & Co., Montreal, Canada

Table I—Case History No. 1—Results from Engineering Approach

Tensile Strength — Pounds Per Square Inch			
Alloy A		Alloy B	
36,075		38,333	
35,612		38,117	
37,881		39,108	
36,623		37,703	
36,909		38,004	
Average	36,620	Average	38,253
Difference B − A = 1,633 psi			

that alloy B is little better than alloy A. Expensive emergency measures would likely be required to rectify the situation. Most undesirable.

The risks that the experimenter is prepared to run are then tentatively selected, bearing in mind the consequences outlined above. Tables are available[6,7] which give, for various magnitudes of process variations and property differences, the number of experimental units necessary for conclusions subject to the selected risks.

If we set the risk for a Type A error as *one chance in twenty* (0.05) and for a Type B error as *one chance in a hundred* (0.01), we find that we would require approximately 50 casts for each of the two alloys, with eight billets* selected randomly from each cast and one test specimen per extruded length (*i.e.*, per billet). If this is impossible from a cost and time

*This figure might be reduced if more test pieces were taken per billet. An estimate of test error would be necessary, however, before this modification could be made.

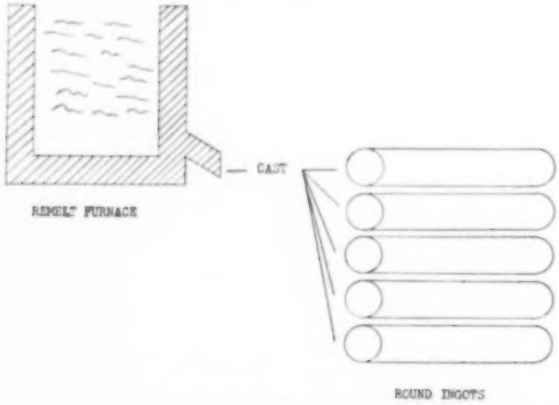

Figure 1A—Diagram Representing the Casting Process (Case History No. 1)

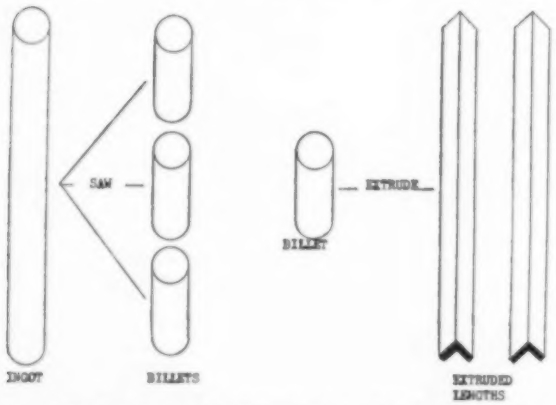

Figure 1B—The Progression from Ingot to Extruded Length (Case History No. 1)

Table II—Case History No. 1—Excerpt from Records Giving Cast-to-Cast Variation

Cast No.	Tensile Strength (Kips Per Square Inch)		Cast No.		
1	38.15		5	38.49	
	36.55			40.05	
	38.55			39.75	
Average		37.75			39.43
2	36.75		6	37.55	
	37.10			38.18	
	36.37			37.60	
		36.74			37.78
3	38.45		7	36.71	
	37.72			38.20	
	36.75			38.70	
		37.64			37.87
4	38.60		8	37.42	
	37.90			37.95	
	37.75			39.15	
		38.08			38.17

Each value represents one test made on one extruded length, i.e. one billet

NOTE: These results were obtained from a study during which triplicate billets from a number of casts were extruded on one press run.

angle, higher risks will have to be accepted. Try 0.10 for the Type A error and 0.05 for Type B. Twenty-eight casts, with eight billets from each cast, will be required for each alloy. If this is still too much work, further compromises must be effected. Whatever the final decision for the number of billets to be run, a random order at the extrusion press is essential to overcome possible systematic effects such as change of operators, etc.

Analysis: The statistical procedure for analyzing the data is prescribed by the design. In this case a Student's t-test would be used to test for the increase. Roughly, the required increase could be claimed if the observed mean difference exceeded 1,240 psi in the first illustration (50 casts *etc.*), or 1,150 psi in the second (28 casts, *etc.*).

Risks for Engineering Approach: If it is assumed that the experimenter in the engineering approach worked on the principle that an observed difference (between averages) of more than 1,500 psi would indicate that alloy B met the requirements, the risks for this experiment are calculated to be *one chance in two* (0.5) for a Type A error and *one chance in three* (0.33) for a Type B error.

In presenting the data it is most useful to attach confidence limits to the difference actually obtained. If 95 percent confidence limits* are affixed to the difference given in Table I, we would conclude that the true increase given by alloy B falls within the range −367 to +3,633 psi.

It should be noted that the statistical approach outlined above is only one of a variety of possible statistical procedures. It was selected for this example because it paralleled the engineer's method. A more economical approach would proceed sequentially, that is, compare only a few casts of each alloy on the first press run, continuing to make further comparisons only if the observed difference was not statistically significant.

Case History No. 2— Isolating Sources of Variation

Problem: In the manufacture of a synthetic latex, the process was found at times to proceed so rapidly that it got out of control. The resultant batches of the material were unsaleable.

Background: It was felt that errors in charging one or more of the eight ingredients were responsible,

*On the average, 95 out of 100 limits determined in this way will include the true difference.

since meter inaccuracies plus operator inattention could lead to errors of ±10 percent.

Remedial Action: A laboratory scale program was initiated to determine the effects on rate of reaction of ±10 percent variations of the eight components.

Two week's work was allocated to the project.

Approach of Chemist

Since only eight recipes could be prepared in a day, the work load was planned as shown in Table III. Only factor (or ingredient) A was varied the first day, everything else being fixed at the standard or "errorless" level. The next day factor B was varied, other factors being fixed. C was varied the third day, *etc.*

In this system, interactions* between the charging errors of different ingredients are not considered.

Each day, two charges were prepared for the *control*, i.e., the standard or *errorless* recipe, to enable the chemist to compare one day's work with another's. This was necessary because of recognized day-to-day differences in charging and processing procedures.

Conclusions: The results were so entangled that no definite conclusions could be made.

Statistical Approach

Stage I: There were 256 possible combinations (eight factors, each at two levels, or $2^8 = 256$) of the various factors at their high (+10 percent) and low (—10 percent) levels. Of these, 32 were selected according to mathematical rules so that:

Day-to-day differences (which included the effect of different technicians) could be separated out in the analysis. This removed the need for "control recipes" as used in the chemist's approach.

The independent effects of charging errors of the eight factors, or ingredients, could be estimated using all of the 32 results each time. The estimates were therefore more precise than those obtained in the first approach which were based on only six results corrected to the level of the control.

The effects of as many as possible of the 28 two-factor interactions could be evaluated. (Seven was the maximum number)

The 32 recipes were then prepared (See days 1 to 4—Table IV).

The results were analyzed at this half-way point. One factor, H, appeared to have little effect, so it was eliminated from the second stage of the study.

*A +10 percent charging error in A might have a different effect depending on whether there is a +10 percent or a —10 percent charging error in B, *etc.*

Table III—Charging Schedule for Chemist's Approach—Case History No. 2

	Recipe		
Day 1			
	1, 2, 3 Factor A +10% level other factors no "error"	4, 5, 6 Factor A −10% level other factors no "error"	7, 8 Control All factors no "error"
Day 2			
	1, 2, 3 Factor B +10% level other factors no "error"	4, 5, 6 Factor B −10% level other factors no "error"	7, 8 Control
	•	•	•
	•	•	•
	•	•	•
	•	•	•
		etc. for Days 3-7	
Day 8			
	1, 2, 3 Factor H +10% level other factors no "error"	4, 5, 6 Factor H −10% level other factors no "error"	7, 8 Control

Stage II: Thirty-two different combinations, this time of seven factors, were chosen to follow up early leads. Days 5 to 8—Table IV.

Final Analysis: All 64 results were analyzed together and it was found that charging errors of the magnitudes studied could account for the process difficulties. Not all of the ingredients were equally critical, however. Four of them accounted for the majority of the fluctuations in rate of reaction. All four interacted strongly.

It was the presence of this interaction which enabled the chemist to locate the real source of the trouble. An impurity, previously thought unimportant, was present in all four ingredients and this impurity had a pronounced, non-linear, effect on the reaction.

As a result of the investigation, the impurity was more closely controlled and the process stopped its erratic behavior. As an unexpected bonus of the tests it was also found that one of the most expensive ingredients in the recipe served no useful purpose so it was eliminated from subsequent material.

In fairness it should be admitted that the statistical approach failed the first time it was applied. The large number of different recipes in a day led to excessive weighing errors which overpowered the experiment. Once this deficiency was recognized, the *chemist* corrected it by an ingenious system of masterbatch solutions. Here was a truly cooperative venture requiring the best of both approaches.

Case History No. 3—Curve Fitting

Problem: To determine the effect of different amounts of *cross-rolling* and *cold reduction* on the *earing* characteristics of a sheet alloy, and so establish operating conditions. See Fig. 2 for an explanation of the terms.

Approach by Engineer

Three levels of cold work were chosen: 80, 87 and 94 percent. These were to be combined with four levels of cross-rolling giving width increases of 0, 25, 50, and 75 percent to make 12 combinations.

Six ingots were rolled for each of the 12 combinations.

Table IV—Various Recipes Used in Case History No. 2—Statistical Approach

Stage I			
Day 1	Day 2	Day 3	Day 4
(1)	afh	abg	bfgh
abcf	bch	cfg	acgh
dgh	adfg	abdh	bdf
abcdfgh	bcdg	cdfh	acd
e	aefh	abeg	befgh
abcef	bceh	cefg	acegh
degh	adefg	abdeh	bdef
abcdefgh	bcdeg	cdefh	acde
Stage II—ingredient H dropped			
Day 5	Day 6	Day 7	Day 8
af	dfg	ad	g
bf	abdfg	bd	abg
cf	acdfg	cd	acg
abcf	bcdfg	abcd	bcg
adeg	e	aefg	def
bdeg	abe	befg	abdef
cdeg	ace	cefg	acdef
abcdeg	bce	abcefg	bcdef

Notation:

The presence of a letter in the code indicates that the corresponding ingredient is present in the recipe at its +10% level.

The absence of a letter indicates the corresponding ingredient is present in the recipe at its −10% level.

(1) indicates that all ingredients are at their −10% levels.

Example

The recipe dgh in Day 1 is made up of ingredients D,G and H at their +10% levels, while the missing ingredients A,B,C,E, and F are at their −10% levels.

One earing test was made on the metal rolled from each ingot.

The results were reported as shown in Fig. 3A.

Statistical Approach

In dealing with data of this nature, the statistical approach makes use of mathematical functions to represent the relationship between the dependent variable, y (earing) and the independent variables x_1 (cold reduction) and x_2 (cross rolling). A function is sought which will approximate the true relationship within the bounds of experimental error.

Generally, when nothing is known beforehand about the form of the function, it is first assumed to be linear, *i.e.*, of the form

$$y = b_0 + b_1 x_1 + b_2 x_2 \qquad (1)$$

The constants b_0, b_1 and b_2 giving "best fit" can be calculated from the observed data and tested for statistical significance. Non-significant terms are dropped and the resulting function is used to represent the relationship if it provides an adequate fit.

For example: Suppose b_0, b_1 and b_2 are all significant. The function if plotted will give a set (or family) of parallel lines, equally spaced. The departures of the observed points from these theoretical lines are compared to experimental error, and if they are of the same order of magnitude—as determined by a statistical test—the calculated function is said to approximate the true underlying relationship within the limits of error of the experiment. (If the form of the function can be estimated, through theoretical considerations or otherwise, this is used and a statistical test is made to see if the observed points fit the assumed relationship)

Should the fit obtained using Equation (1) be inadequate, a function of second degree is calculated if the levels of the independent variables permit it.

$$y = b_0 + b_1 x_1 + b_{11} x_1^2 + b_2 x_2 + b_{22} x_2^2 + b_{12} x_1 x_2 \qquad (2)$$

The extent of the deviation is again compared to experimental error and, at the same time, the constants b_0, b_1, b_{11}, *etc.*, can be tested for the significance of their influence.

If when all non-significant terms have been eliminated the remaining function does not give an adequate fit, a more complex function is fitted and tests of significance again applied. This process continues until (a) an adequate fit is achieved (b) the limitations of the data force a halt or (c) the statistical analyst runs out of functions.

In the example given, a second-degree function sufficed:

Earing $= 10.26 - 0.189R + 0.069W - 0.000613W^2$

(See Fig. 3B).

The advantages of this approach are great:

1. A systematic and objective method of curve fitting is provided. The resulting curve pattern is generally simple (without many dips and bends) and within the precision warranted by the data.

   In the absence of such a method and when the relationship is unknown, an experimenter can only fit a curve to the data points by eye, a practice which results in the complex picture presented by Fig. 3A. Should the experiment be repeated, it is likely that a different configuration of curves would result—leading to different conclusions. The statistical approach tends to minimize the fluctuations of curve patterns from one experiment to another, while maintaining adequate fit.

2. The curves obtained from an experiment of this sort are used to give information concerning the mechanism relating the factors and to allow the selection of optimum operating conditions. (In our example conclusions based on Fig. 3A differed somewhat from those based on Fig. 3B).

   By using the mathematical form of the relationship and differentiating it is possible to estimate the value of W (amount of cross rolling) giving the maximum line on the graph. (From Fig. 3B it is not evident whether this lies be-

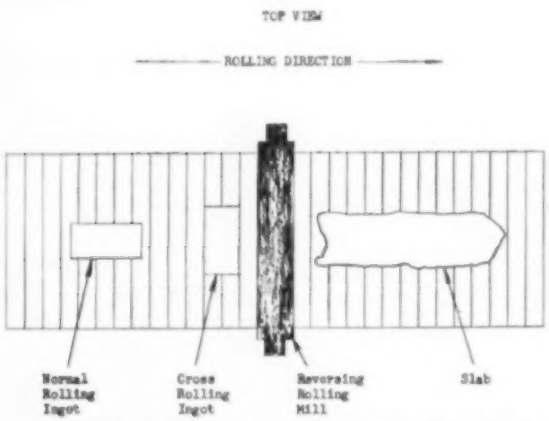

Figure 2A—Ingot Positions in Sheet Rolling (Case History No. 3)

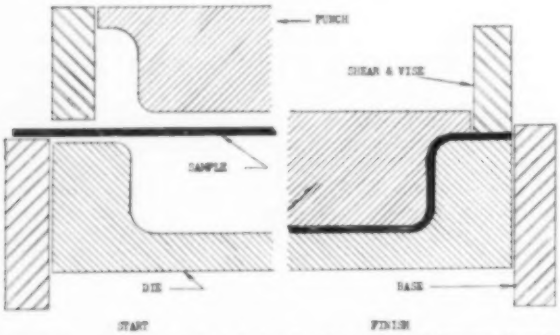

Figure 2B—Forming the Test Earing Cup from a Small Circular Sample of Sheet (Case History No. 3)

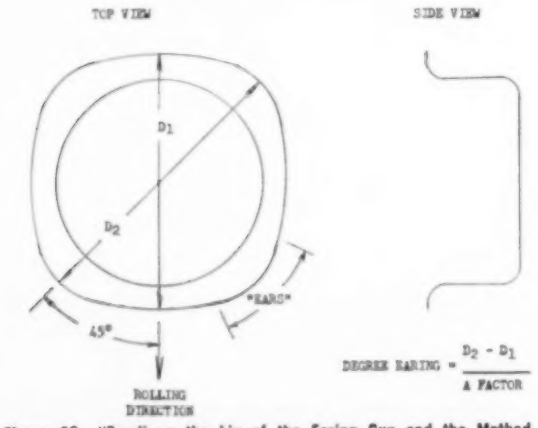

Figure 2C—"Ears" on the Lip of the Earing Cup and the Method of Assessing the Degree of Earing (Case History No. 3)

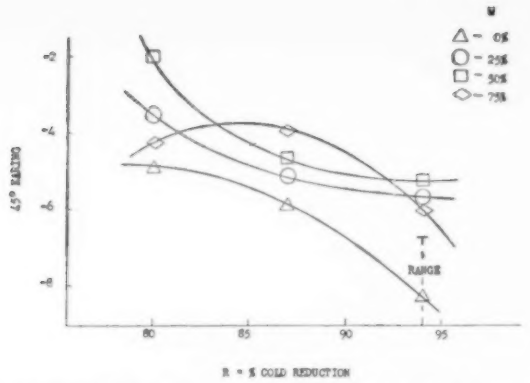

Figure 3A—Earing vs. Cold Reduction and Cross Rolling Graph Prepared by the Engineer to Report the Data Obtained in Case History No. 3

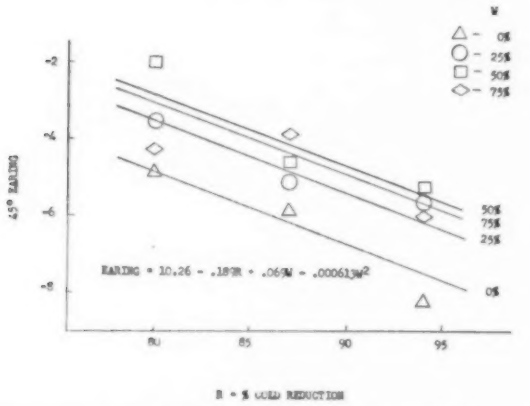

Figure 3B—Earing vs. Cold Reduction and Cross Rolling Graph Prepared by the Statistician to Report the Data Obtained in Case History No. 3

tween 25 and 50 percent or between 50 and 75 percent.) The equation is also convenient for estimating the earing level for intermediate values of cold reduction and cross rolling.

As it turned out, the metallurgist was much happier with the curves given in Fig. 3B, since he believed the relationship between earing and cold reduction was linear but did not know how to go about fitting such curves objectively.

Summary

To summarize, then, the use of modern statistical techniques in experimenting offers the following benefits:

For the experienced experimenter:

Provides an objective method of dealing with variation and assessing risks.

Introduces the idea of efficiency in experimentation (i.e., oftentimes less work can give the same information).

Provides a systematic approach to problems involving a large number of factors.

Makes popular the use of mathematical functions to represent curves.

For the inexperienced experimenter:

It insists on careful preliminary planning and focusses attention on questions too likely to be glossed over in the rush to get to work. In other words, the scientific method is formalized into a set of questions which must be answered before the statistical design can be selected.

D. S. McArthur and J. J. Heigl[8] have written a very interesting paper on research strategies. One of their conclusions is that a "best" strategy must possess the following characteristics:

It makes use of the information as it is collected.

The master strategy allows for changes in procedure, depending on what results come in.

Different levels of screening are involved so that unimportant variables are dropped early.

The limits of the operating variables must somehow be defined. Often the limits of one variable depend on the levels of the other variables.

There must be present a boldness to explore the unknown.

Decisions must be made with a calculated risk.

There will be a rule for deciding when to quit.[9]

Experience has shown that statistical methods are essential for the formulation and implementation of such strategies.

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Reliability and Statistical Control

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> In applying statistical theory the main consideration is not what the shape of the universe is, but whether there is any universe at all. No universe can be assumed, nor the statistical theory of this book be applied, unless the observations show statistical control—W. Edwards Deming, *Some Theory of Sampling*, p. 502, John Wiley & Sons, 1950.

SO MUCH has been said and written about statistical quality control that sometimes we lose sight of the underlying philosophy.

Perhaps fresh emphasis should be placed upon the broader implications of statistical control in relation to the stability of cause systems in general and to the soundness of inferences that are drawn about the conditions within cause systems at progressive intervals of time.

It is hoped that the following discussion may point up some of the ways in which statistical control concepts can add to success in making reliable decisions about future results in experimental and production operations.

Cause-System O

In symbolic form, let O be a cause-system or "operation" that generates populations of characteristics $C_1, C_2, \ldots C_N$. These in turn are estimated from sample observations $(X_{i1}, X_{i2}, \ldots X_{in})$ on each of the C_i. In this concept the X_{ij} are individuals taken from the populations C_i of characteristics. However, the generating cause-system O is an abstraction, an interplay of forces derived from the design (natural or human) of the "operation."

Such a cause-system O may arise from the interplay of natural laws such as those concerned with radiation, atomic structure or energy fields; or it may be concerned with biological laws such as Mendelian heredity or growth curves; it may involve sociological or economic relationships such as the distribution of age groups, population movements or sales volumes; or it may arise from experimental or manufacturing processes.

The system of causes that defines the operation O cannot be analyzed directly. Only the measurable characteristics observed in the X's can be analyzed. Any judgment about the C's or about the operation O can only be inferred from the X's.

Furthermore, analyses for the purpose of action (which, with knowledge, is the only useful purpose that analysis can serve) involve inferences that the future will bear a predictable relationship to the past.

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A triple inference is therefore involved: from X_{ij} to C_i to O at the present time to O at a future time. Schematically,

$$\begin{array}{c} O_{t_1} \\ \uparrow \\ X_{ij} \rightarrow C_i \rightarrow O_{t_0} \end{array}$$

Notice that emphasis is placed upon the predictability of the cause system rather than upon the C's or the X's.

The inferences $X_{ij} \rightarrow C_i \rightarrow O_{t_0}$ do not involve time, hence do not involve prediction. The limits of error within which this first type of inference can be made have been well explored by probability and statistical distribution theories and have been tested in a multitude of applications.

Second Type of Inference

The second type of inference $O_{t_0} \rightarrow O_{t_1}$, involving the time element, adds a second dimension which differentiates it from the static type of inference and calls for theories and techniques of statistical analysis that include $t_0, t_1 \ldots t_k$ as basic factors. The concept of statistical control satisfies this need. Without it no valid time-prediction can be made nor can any quantitative measure of reliability be assigned to the inference $O_{t_0} \rightarrow O_{t_1}$. If, however, we observe a state of statistical control in the samples $(X_1, X_2 \ldots X_{n_0})t_0$, $(X_1, X_2 \ldots X_{n_1})\ t_1, \ldots$ $(X_1, X_2 \ldots X_{n_k})t_k$, we can infer a state of stability among the causes operating in $O_{t_0}, O_{t_1}, \ldots O_{t_k}$.

Thus the word "stability" as used here acquires an operationally verifiable meaning when defined as a "state of statistical control." That is,

> If $O = O[S]$ (which is read, "the operation O is in a state of statistical control"),
>
> then $O_{t_0} = O_{t_1}$ and O is a 'reliable operation' in the sense that the C_i will be random variables at both t_0 and t_1, with parameters $\theta'_{1,2\ldots m}$ whose values as estimated from the sample X's approach $\theta_{1,2\ldots m}$ as statistical limits at both times t_0 and t_1. Stated symbolically,
>
> If $O = O[S]$, which is also termed a "system of constant causes" (i.e., in a state of statistical control), then
>
> $\lim_s \theta_k = \theta'_{t_0} = \theta'_{t_1}$, where $\lim_s$ is a statistical limit and θ' is the unknown but estimated true value of the parameter of the characteristic C_i as generated by the stable operation O.

Time Inference—The Basic Purpose

Notice how fundamentally the time element enters into the concept of statistical control. This is one of its major contributions to statistical methodology;

that samples are taken in chronological order and treated to reveal non-chance variations time-wise in the probability sense. Thus the methods of statistical control permit sound inferences to be made from O_{t_0} to O_{t_1}, *i.e.*, that $O_{t_0} = O_{t_1}$. Time inference is the basic purpose of statistical control work.

This inference cannot be wholly logical, for all inferences contain subjective elements of decision. It can, however, be observed as a fact of experience, and has been so observed by many people over a period of more than thirty years. From this experience is derived the following axiom:

> An operation that is in a state of statistical control tends to remain in that state as long as it is functioning under essentially the same conditions.

The words "under essentially the same conditions" mean what scientists think of as the reproducibility of experiments. If scientist A performs an experiment E with results R, then he or any other qualified scientist, knowing the circumstances, methods and equipment, should be able to duplicate the result R by performing the experiment again "under essentially the same conditions." If this is operationally defined as both experiments being in a "common state of statistical control," it has been shown† that some of the most elite of scientific measurements, e.g., those determining the velocity of light, have *not* been performed "under essentially the same conditions." This conclusion is a startling one and emphasizes the need for an objective criterion for establishing the reproductibility of experiments. Statistical control methods provide just such a criterion, *i.e.*, that $E_1 = E_2$. It becomes clear, therefore, that statistical control procedures can be as useful in experimental work as in production, and can bridge the gap between the two.

From Experiment to Production

Because the transition from experiment to production is one of the principal qualitative sources of unreliability in a finished product, the reduction of the transition-risk is a valuable contribution of statistical control techniques to establishing the reliability of behavior characteristics among the C's.

Unfortunately, many characteristics C of an operation O are not measurable, or are measurable only at an uneconomic cost. Sometimes this is true of the most important characteristics.

Taking examples from the field of manufacturing operations, one can name the internal structural faults of metals, certain chemical reactions, dimensions that cannot be gaged, destructive testing, or the final characteristics of a complicated assembly. Many such intangible factors have to do with "design intent," that is, the performance of a satellite under the untestable conditions of outer space, or the creation of customer satisfaction with a product or the artistic appeal of a fine instrument.

Many of the examples of non-measurable characteristics can be found in market research, sociology, and economics.

Symbolically, let an asterisk (*) indicate a non-measurable characteristic generated by the cause-system O, so that the C's may appear as C_1, $C^*_2 \ldots C_n \ldots C^*_{n+k}$. Here another axiom of statistical control, drawn from extensive experience, bridges a second inferential gap:

> If a cause-system exhibits statistical control as inferred from samples taken from the universes of measurable characteristics, then it can be inferred that the non-measurable characteristics generated by the same cause-system will also be in statistical control.

Symbolically, if

$$C_{a,c,e,\ldots} = C[S], \text{ then } C^*_{b,d,f,\ldots} = C[S]$$

This is true because a state of statistical control represents a cause-system in which conditions remain "essentially the same" and "random" during a lapse of time — a state achieved by the elimination of assignable causes from the system. An assignable cause is defined as a factor in the operation O that is powerful enough to generate significantly non-random behavior among the sample X's.

By the same token, when the sample X's do exhibit random behavior, as if they were chips drawn from a bowl, they are said to demonstrate a state of statistical control, which then becomes an operationally verifiable definition of randomness — a definition which fills an oft-neglected need in the statistical handling of data. In other words, if the X_{ij} show statistical control, it can be assumed that the C_i are generated by an operation O which consists of "a constant system of chance causes." In fact, such a system can be treated with all the keen tools of statistical analysis *just as if time were not a factor.* Thus the uncertainties brought in by the second dimension of time-prediction can be eliminated and the scheme of inference shown earlier can be rewritten:

$$X_{ij}\,[S] \rightarrow C_i\,[S] \rightarrow O_{t_0}\,[S] \rightarrow O_{t_1}\,[S]$$

In experimental and manufacturing operations it is usually desirable and possible to alter the cause-system O so that it will generate parameters among the characteristics C_i which can be held within limits determined by specifications, consumer wants and other types of requirements. When this is done the operation is said to be producing "at a satisfactory level." If, and only if, it is also "in control" can statistical probability and distribution theory properly be applied to the analysis of the observations X_{ij}. An operation which is "in control at a satisfactory level" assures the maximum degree of objective rational belief that the results of the operation will be predictably successful. This is the ultimate purpose of the application of statistical control techniques.

Predictable in the Probability Sense

The words "predictably successful" and "reliable" are synonymous and thus gain specific semantic content, because they mean "predictable in the probability sense." That is, statements can be made about the behavior of the populations of characteristics to which definite probabilities of error can be attached. In this way it becomes possible to calculate the risk of failure and weigh it against the cost of failure in order to determine the most desirable degree of reliability that should be aimed at. If, however, the operation is not in a state of statistical control, the behavior of its characteristics cannot be predicted with pre-determined probabilities; hence the economic balancing of risk against cost cannot be carried out. This is why Dr. Deming made the statement quoted at the beginning of this article, and why Dr. Walter A. Shewhart entitled his pioneering book in 1931 *The Economic Control of Quality of Manufactured Product.*

†Shewhart, Walter A., *Statistical Method from the Viewpoint of Quality Control*, p. 66 ff.

The Challenge of Visual Inspection In the Electronics Industry

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THE WIDE-SPREAD prevalence of visual inspection for various attributes in the electronics industry and elsewhere emphasizes the need for an objective program to achieve a degree of precision in this area. The scrutiny of small parts for minute defects day by day in a routine fashion gives the appearance of a thorough quality audit. It is an underlying fact, however, that any statistical tool is no better than the data to which it is applied. Once on paper, data taken to vague, unrealistic standards can be the "wolf in sheep's clothing" ready to devour both the engineer and his methods, however sophisticated.

The principal advantages of visual inspection are relative high speed and low cost.[14] Many inspections cannot be carried out using measurable characteristics or are so subjective in nature that they demand sensory inspection by human beings. Electrical parameters are often dependent upon visual characteristics which cannot themselves be measured, gaged, or metered. They must, then, be inspected visually. Unfortunately, such inspections may result in variation from one inspector to another, bias on the part of individual inspectors, and a general lack of discrimination of all concerned.

In general, much can be done to reduce the intangible aspects associated with visual inspection. The heart of visual inspection lies in the brains and eyes of the inspectors themselves. The selection and training of these individuals are of prime importance in ensuring that a competent job will be done at the workplace. The method employed in setting up and performing a visual inspection is directly associated with the reliability of the results. Any such inspection should also involve formal or informal checks to avoid bias and differences among inspectors. The purpose of this paper is to review the general methods of ensuring good inspectors, a good inspection, uniformity between inspectors, and consistent objectivity in inspection results, combined into an integrated program of visual inspection.

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The Inspectors

The need for special care in the selection and training of inspectors is obvious. Visual inspection, however, requires characteristics beyond those usually demanded of a competent inspector.

In a comment on an article appearing in the "Supervisor's Circle" Department of *Industrial Quality Control*, P. A. Robert, the editor of the Department, said,

> The proper examination of the inspector's eyes is as important to visual inspection as the control of gages to mechanical inspection. Since visual characteristics contribute the largest single category in the field of Quality Control it behooves the Quality Control Manager to take an interest in the scientific methods and devices available for improving the effectiveness of the visual inspection in his plant.[11]

Such methods are, in fact, used extensively by enlightened management. Bausch and Lomb's *Ortho-Rater*, Keystone's *Telebinocular* or American Optical's *Sight-Screener* are examples of instruments which measure vision at close range, so important in this type of inspection. Such devices can reveal: (1) visual acuity at close range or at a distance, (2) depth perception (3) color vision and (4) extrinsic muscle balance.[11]

The experience of Dr. Herman Sager of the Sperry Gyroscope Company indicated that when a test of this nature was instituted approximately 50 percent of the employees were found to have defective vision and were unaware of the condition.[11] An Ortho-Rater, combined with the Drake Visual Test, has been successfully used at the Perfect Circle Corp.[3], while at Western Electric the same device was shown to be a good predictor of visual inspection performance.[4] At Western Electric a special unit was built containing 30 defective solder connections of varying severity: of 39 inspectors who inspected the units visually, 15 out of the 21 who found less than 90 percent of the defects had defective vision, six out of the 18 who found more than 90 percent of the defects had defective vision.

Vision tests can also be predictors of terminations. In one study, vision tests were administered to 99 inspectors in one manufacturing company. While 43 percent of those who passed stayed on the job more than eight months, only four

percent of those who failed were there eight months later.[9] Tolerances are becoming too thin and dimension too small to entrust anyone with a visual inspection without confidence that he is physically able to perform the task.

Psychological tests also play an important part in the selection of good personnel for visual inspection. As J. M. Juran has said, "There is a difference between the *true quality* and the *picture of true quality* because of human beings present in this picture."[5] That picture is the quality as interpreted in the mind of the inspector. In Great Britain, a group of tests devised by The National Institute of Industrial Psychology successfully distinguished the worst from the best inspectors in a visual situation.[13] Reinspection indicated that the worst made two and a half times as many mistakes as the best and that errors would have been reduced by 23 percent if these tests had been administered before the inspectors were hired. The tests were based on resistance to boredom and visual acuity rather than intelligence and high-speed perception which would normally be thought of as prime characteristics of good inspectors. Western Electric found the Industrial Training Classification Test, Purdue Form B. Kuder Preference Record Form BB, Guilford-Martin Personality Inventory I, and the Minnesota Paper Form Board Test, Series BB useful in determining good visual inspectors.[4]

The Inspection

Before setting up a visual inspection, it is well to have in mind the working conditions under which the inspection will be carried out. While sampling plans have reduced the amount of monotony associated with this type of inspection,[2] it is still true that a critical visual analysis of many small pieces should be performed under good working conditions if reliable performance is to be expected. Such factors as high level of ambient noise, high environmental temperature, difficulty in level of detection of defects, and loss of sleep have been found to be directly associated with inspection inefficiency.[1] A well arranged workplace and adequate lighting are essential; in one study the number of "rejects" was cut in half by improving these factors.[1] Adequate lighting implies the use of black light, polarized, reflected, edge light, and the like, whenever necessary to emphasize the defects involved.[8]

Vague equivocal statements of what to look for in a visual inspection are undeniably an evasion of responsibility on the part of the engineer, resulting in a transfer of the burden of defining good and bad quality to the inspector. Such a shift can benefit no one. Rather, the engineer should so define a visual defect as to minimize the inevitable number of "doubtful" cases. Since it is generally accepted that human beings make relative judgments easier than absolute ones, an excellent method of visual inspection is to present the inspector with a set of samples ranked in order of severity of a given defect and marked as to the point at which rejections should occur. The delineation of such a point can be generally agreed upon by those concerned: plant foreman, inspection foreman, engineer, sales manager, and others. The samples can be collected over time or deliberately made to order. Sometimes they are photographed for ease of handling and permanence. Stereo slides afford an excellent method in cases in which depth perception is involved. It is generally conceded that these "limit samples" should be as large in number of degrees as possible so that "interpolations" between critical samples will not become necessary. It is eventually possible to collect a museum of defects[10] readily accessible for inspection or investigation.

Application of the "limit samples" concept is illustrated in the manufacture of television faceplates. Prior to the use of such samples, inspectors were simply told what defects to look for. In the six months after limit samples were set up, inspection accuracy improved 76 percent.[6]

A variation on the idea of "limit samples" involves treating essentially attribute data as if it were variable. This treatment can be achieved by numbering each item in the sample and recording the comparative value of each unit involved in the inspection. This method allows for an accumulation of history on a process, and a closer touch with the actual process itself allows trend analysis even when there are no rejects. It also forces the inspectors to refer to the limit samples. A recent application of this method to a set of shop-worn "limit samples" at RCA, Somerville, N.J., brought objections from the inspectors because of the time involved referring to the samples. This situation was an indication that the samples were not being referred to properly before the adoption of the variables method. Undoubtedly the inspectors were also aware that the variables approach allows for a check on the inspector's work.

It has been said that the more people that are associated with visual inspection the more difficult it becomes.[3] While this may be true, the method of inspection should be such that all concerned are as fully aware as possible of the criteria involved. Only in this way can inspection for visual attributes attain a degree of precision approaching that usually associated with measurable characteristics.

Consistent Objectivity

Even the most tightly controlled visual inspection may be subject to bias and inconsistency on the part of the inspectors. There are a large number of studies which show these factors do exist and may be quite severe in scope.[3, 4, 7, 10, 13, 14] Pressures exist on the incoming, final, or process inspector from other production, purchasing, sales, or quality personnel who have a direct interest in the disposition of a lot. Even in the absence of such pressures, the desire to terminate work may influence an inspector using a multiple sampling plan.[12] Subconscious or deliberate nonrandom sampling techniques can also bias the results of a visual inspection. It must be remembered that in picking a sample the inspector may be utilizing the same criteria that he will later use for acceptance or rejection. Random numbers or adequate mixing should be used where possible in the selection of a sample. Cases are recorded of personal bias against an individual worker on the part of an inspector. Inspectors are sometimes affected by a "halo" effect in which their decisions on a particular lot are unduly influenced by their recollection of past quality.[10]

Most often inspectors will be found who have a reluctance to reject or who are unwilling to accept.[14] These are the traditional types of inspection proclivity. Inspector "flinching" is of this type. A most interesting analysis of the effects and types of inspection bias

in dealing with borderline units has been put forth by Julian Toulouse.[14]

Inspectors are often inconsistent over time, particularly with regard to the time in a shift the inspection is performed.[14] It has been found that while the general rate of inspection error remains the same throughout a given shift, the effect of monotony or fatigue on men is to lower the standard of inspection so that fewer good units are rejected and more bad units pass.[13] It is suspected that the reverse may tend to happen with women, i.e., that they become more fastidious with the onset of fatigue.

Recognition of the possibility and the scope of inspector bias and inconsistency implies the advisability of the use of means of detecting and correcting such phenomenon. A well conceived and executed visual inspection can easily be the source of misinformation under such circumstances. Several methods have been suggested for detecting inconsistency of inspection.

Several methods of detecting an inconsistent bias on the part of an inspector are suggested by David A. Schwartz.[12] If the process from which the samples are taken is in control, the percentage of lots accepted by an inspector over a given period can be compared with the probability of acceptance for that process average as shown by the OC curve. Should there be a significant difference there is an indication of bias. In double or sequential sampling the process average of the first sample can be compared with that for the second. With single sampling plans, this method could be used by comparing both halves of a sample. A check can also be made on the number of consecutive lots accepted as compared with the probability of such a run of acceptances derived from the OC curve at the current process average. In the event the process is not in control, the process average cannot be determined. In this situation, Mr. Schwartz suggests that in using a multiple sampling plan, the actual number of units inspected per lot be compared with the ASN (Average Sample Number) curve for the particular percent defective indicated by the inspection to be in that lot. These methods work for an inconsistent bias; however, if an inspector is consistent in his bias, other methods must be tried.[12]

Consistent bias can be detected by reinspection or by comparison of the process averages of various inspectors on the same process. This comparison can be made by t-test, chi-square, analysis of variance, or careful observation of control charts. The possibility also exists of tests of inspectors against a prepared population with a known percent defective. Any of the tests discussed would thus apply against a known process average. Inconsistent bias might also be revealed by these methods. It has been suggested that if the actual distribution of the number of rejects found per inspection is compared with the theoretical binominal distribution of the given percent defective found by the inspector, the signed differences will assume a certain pattern according to the particular bias of the inspector.[14] Chi - square tests against these theoretical models will reveal differences in inspectors. Another study indicates that if the number of rejects found per inspection is plotted in a simple histogram for a given sampling plan, patterns will often be revealed which indicate the bias of the inspector.[5] Thus, inspector "flinching" would be shown by an unusually low frequency of defects in the class after the point of rejection and a high number in the preceding class.

The various methods proposed must be adapted to particular situations. In general, however, it is well to consider incorporating a formal check system into visual inspection to insure the maintenance of objective standards.

Integrated Program

Since certain characteristics are amenable to inspection only by visual techniques, a general overall approach should be adopted for this type of inspection. Visual inspections currently being used should be re-evaluated in the light of this approach and new inspections set up accordingly.

A program of this sort must come from the managerial level and demands the cooperation of all concerned. It is necessary to establish the physical and psychological capabilities of those who are to perform this type of inspection. This effort is much like the calibration of test instruments in the case of dimensional checks. Furthermore, a critical evaluation of the working conditions under which this type of inspection is to be performed must be made, and changes effected where possible. This task is not the job solely of personnel or of plant engineering; it is the responsibility of Quality Control to insure that its inspections are being carried out under optimum conditions by capable inspectors.

In *visual* inspections, *visual* standards must be provided and well defined so that equivocation can be avoided. One method of providing these standards is in the form of limit samples, ranked in order of defect with good and bad quality clearly delineated. Actual units can be used for the samples although black-and-white, color, or three-dimensional photographs provide reproducibility and convenience of storage. Standards once set should be maintained as long as possible since confusion can result from frequent changes in what is essentially a subjective inspection. Numbering each item in the limit sample allows for the application of variables criteria to what is normally an inspection for attributes. This system makes available historical data, a basis for comparison of quality between productive units, and the possibility of using variables rather than attribute control charts.

Limit samples with clearly defined acceptance/rejection criteria provide an excellent means of training inspectors. Supervisory training and proper instruction of inspection personnel is essential to an effective approach to visual inspection. Just as important, however, is a continuing program of re-education so that inspectors are constantly aware of the standards involved.

Formal or informal checks should be built into the visual inspection system. These checks provide the supervisor with data otherwise unattainable and help to insure the reliability of the inspection being performed. The methods suggested in the literature of quality (see bibliography), many of which are described above, are, on the whole, too cumbersome to be applied by a working supervisor on a frequent basis. They are useful as informal checks and as confirmation of suspected bias, but are not easily adapted for regular use by inspection foremen.

A ready solution to the problem of continuing checks on the inspector lies in the control chart itself. If more than one inspector is sampling from the same process,

identification of the point plotted by each inspector makes comparison easy. A color or number assigned to each inspector and recorded near the point plotted is all that is required for each inspector to be analyzed individually as to trend, number of points above or below the center line, number of consecutive points out of control, and the like. When the work of several inspectors is plotted as one point on a control chart, individual records should be kept and points plotted on a separate control chart (with appropriate limits) kept by the foreman or group leader. If there is only one individual performing an inspection, consistency may be judged using the methods stated in the literature. All these methods apply not only to visual inspection but to any type of inspection being performed.

The true challenge of visual inspection should not be met by the inspector, but by those responsible for setting up the inspection. Foresight, sound quality practices, and built-in checks can and should eliminate much of the aura of vagueness which frequently plagues inspections of this type.

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The $\bar{X}$ Warning Limit Chart

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Introduction

A CONTROL CHART is a device for detecting changes in a process. The *effectiveness* of a chart is measured in terms of the probability of detecting a deleterious change in the process — frequently shown in the form of an Operating Characteristic (OC) Curve.

The *efficiency* of the chart may be expressed in terms of the amount of inspection required for various conditions of process operation — commonly shown as the Average Sample Number (ASN) Curve.

The design of a control chart consists of attaining a proper balance between measures of effectiveness and efficiency.

$\bar{x}$ Chart Designed to Detect Changes

Specifically, the $\bar{x}$ chart is designed to detect changes in the process mean, $\bar{x}'$. The control limits are almost universally placed at $\bar{\bar{x}} \pm 3\sigma_{\bar{x}}'$ (or the corresponding 0.001 probability limits used by the British), and we shall assume the use of "three sigma" limits throughout this article. With fixed

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control limits, the sample (n) completely determines both the effectiveness and efficiency of the chart, with greater effectiveness attainable only through the use of larger sample sizes.

A number of devices have been proposed for increasing the efficiency of the $\bar{x}$ chart — i.e., the use of the theory of runs, sequential sampling methods, running averages, etc. Many of these methods require the use of special charts or tables, complex decision rules, or special computations. They violate one of the cardinal principles of practical Statistical Quality Control — *techniques must be simple if they are to be practical and useful.*

Because of its simplicity, the $\bar{x}$ chart with *warning limits* is perhaps the most practical and popular of the modified $\bar{x}$ charts proposed to date.

No special tables, charts, or computations are required, and the decision rules are extremely simple and intuitively appealing. It is the purpose of this article to show how to construct warning limit charts of optimal efficiency, and to show how the characteristics of such a chart vary with the maximum permissible number of auxiliary samples.

The $\bar{x}$ Chart With Warning Limits

Warning limits on an $\bar{x}$ chart consist of a pair of limits placed inside the control limits. The chart is then divided into three regions (see Fig. 1):

S) The *safe* region — inside the warning limits (indicates the process is in control and sampling should proceed at the normal sampling intervals).

A) The *action* region — outside control limits (indicates that the process is out of control and that investigative and corrective action should be undertaken), and

W) The *warning* region — between the warning and control limits (alerts the operator that the process may be going out of control and calls for an auxiliary sample to provide additional information for making a decision).

One of the important characteristics of a warning-limit chart is the distance of the warning limits from the center line ($\bar{\bar{x}}$). The warning-limit factor, L, will be used to designate this distance in standard deviation units (i.e., the warning limits are placed at $\bar{\bar{x}} \pm L\sigma'_{\bar{x}}$). Another significant factor is the maximum number, M, of auxiliary samples which we shall permit between normal sampling intervals. For brevity, we shall refer to M as the number of auxiliary stages — or simply as the *number of stages* — for the warning-limit chart.*

The decision rules for a warning-limit chart may be summarized in the form of a block diagram (see Fig. 2). The diagram shows that sampling proceeds at the normal sampling intervals as long as the sample values (the $\bar{x}$'s) fall in the safe region. If the normal sample falls in the action region, the process is investigated and any required corrective action is taken; we then return to sampling at the normal intervals. If the normal sample falls in the warning region, an auxiliary sample is taken and the indicated decision made (i.e., process is in control, return to normal sampling; or process is out of control, correct process; result is indecisive, take an additional auxiliary sample). Auxiliary sampling continues as long as successive points continue to fall in the warning region — until the Mth stage is reached (i.e., until the maximum permissible number of auxiliary samples have been examined). At the Mth stage, the process is judged to be in control *unless* the sample falls in the action region, thus effectively terminating the auxiliary sampling.

*Note that M = 0 corresponds to the ordinary $\bar{x}$ chart without warning limits.

Design of Warning-Limit Charts

The design of a warning-limit chart involves the choice of the sample size (n), the warning-limit factor (L), and the number of stages (M). One usually seeks the most efficient chart providing a specified degree of effectiveness. However, practical considerations may modify the procedure in some cases.

The required degree of effectiveness or protection is usually specified by prescribing that a given deleterious change in the process mean (say from the "in control" value of $\bar{\bar{x}}$ to some value $\bar{\bar{x}} \pm K\sigma'_{\bar{x}}$) be detected within one normal sampling time interval with a high probability (say P_d). Such a specification will insure that only a small fraction ($= 1 - P_d$) of the time will such an undesirable change go undetected for more than one normal sampling time interval. There will generally be many possible warning-limit charts which provide the desired degree of protection. The choice among these possible charts is normally made on the basis of efficiency.

The efficiency of a warning-limit chart is measured in terms of the average amount of sampling required per normal sampling interval — when the process is operating normally (i.e., in control with average $\bar{x}' = \bar{\bar{x}}$). By minimizing the amount of "in control" sampling we effectively minimize the normal inspection costs of operating the chart. If the process goes out of control, then the amount of sampling may increase. Thus, the chart operates with low average cost when the process is in control and the higher average cost of detecting out of control conditions are incurred only when a change in the process average has actually occurred.

A mathematical analysis of the problem (for details see the Appendix) reveals that the efficiency of a warning-limit chart (with given P_d) increases with M (i.e., larger values of M require less inspection, on the average). Thus, to obtain the least average amount of inspection we should make M as large as possible — in the limit, making $M \to \infty$. However, practical considerations may force us to limit the value of M—for example, we may not wish $n \times M$ to

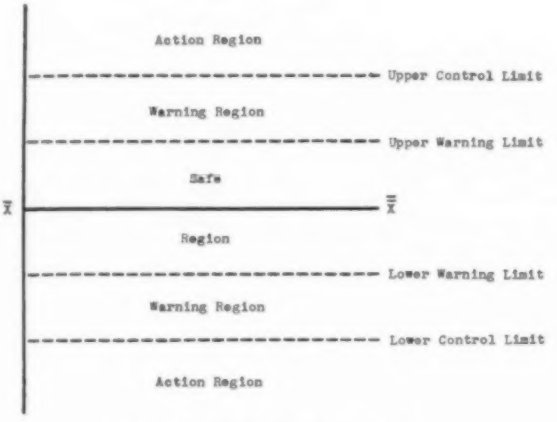
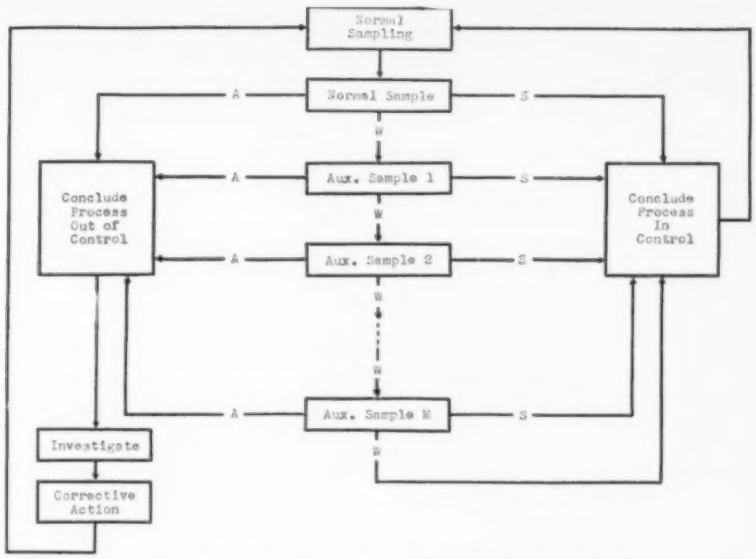


Figure 1—Warning Limits on an $\bar{x}$ Chart



(A means sample falls in action region of chart, S in safe region and W in warning region)

Figure 2—Block Diagram for Warning-Limit Chart

exceed the total output of the process during a normal sampling interval. The results in the following sections are therefore presented for a variety of values of M to provide a basis for practical choices. (It will be noted that the values for $M = 8$ or 10 differ but slightly from the values for $M = \infty$, so that the results for $M = \infty$ may be used for any large value of M.)

Optimal Choice of L and n

For specified choices of the number of stages (M) and the desired probability (P_d) of detecting an undesirable shift (of $K\sigma'_{\bar{x}}$) units in the process mean, the values of sample size (n) and warning-limit factor (L) which minimize the average amount of "in control" inspection ($\bar{N}$) may be found from Fig. 3. The solution procedure will be illustrated by an example.

Example 1

Suppose that we wish to detect a change in the process mean of $K = 1.5$ standard deviations at least 95 times out of 100 in one normal sampling interval. Further, practical considerations limit us to a maximum of $M = 4$ stages. What sample size and warning-limit factor should be used to minimize average "in control" inspection?

Entering Fig. 3 with $M = 4$ and $P_d = 95$ percent we find (on the left hand scale) that the warning-limit factor $L = 1.37$, and on the bottom scale we read $K\sqrt{n} = 3.29$. Then $n = (3.29/1.5)^2 = 4.81 \approx 5$, and so the solution is

> Use a sample size of five and place the warning limits 1.37 $\sigma'_{\bar{x}}$ on either side of $\bar{\bar{x}}$.*

The chart in Fig. 3 provides a very simple method of finding the optimal values for L and n for almost any conceivable situation which might be encountered in practice. (The methods used in deriving the values shown in Fig. 3 are explained in the Appendix.) The chart may also be used to evaluate proposed solutions, as illustrated in the following example.

*The rounding of the sample size from 4.81 to 5 actually increases P_d to 96.3 percent.

Example 2

Suppose that having obtained the solution ($L = 1.37$ and $n = 5$) to the problem of Example 1, we decided that a sample size of four would be more practical, but that we could perhaps then increase the number of stages to six. What would the optimal choice for L be and what would be the probability of detecting a change of 1.5 $\sigma'_{\bar{x}}$ in the process mean?

Entering Fig. 3 with $K\sqrt{n} = 1.5 \times \sqrt{4} = 3$ and $M = 6$, we find the value of $L = 1.29$ and $P_d = 92\%$ (approximately). We are now in a position to judge whether the greater convenience of a sample size of four is sufficient to compensate for a reduction in P_d from 95 to 92 percent.

Average Amount of Inspection

Knowing P_d and M, the average amount of "in control" inspection (I_o) required by an optimal solution is easily obtained from Fig. 4. I_o is the average number of samples (each of size n) which must be inspected during each normal sampling interval when the process is operating in control with process mean $\bar{x}' = \bar{\bar{x}}$.

Example 3

For the data of Example 1 with $P_d = 95$ percent and $M = 4$, Fig. 4 shows a value of $I_o = 1.20$. The total average number of pieces which must be inspected per sampling interval is then $I_o \times n = 1.20 \times 5 = 6.00$ (when the process is in control).

For the data of Example 2 with $P_d = 92$ percent and $M = 6$, Fig. 4 yields $I_o = 1.24$ and so the total average number of pieces inspected per sampling interval is $I_o \times n = 1.24 \times 4 = 4.96$. This represents a saving of about one piece inspected per sampling interval over the requirements of Example 1.

A further measure of interest is I_K, the average number of samples of size n inspected per sampling

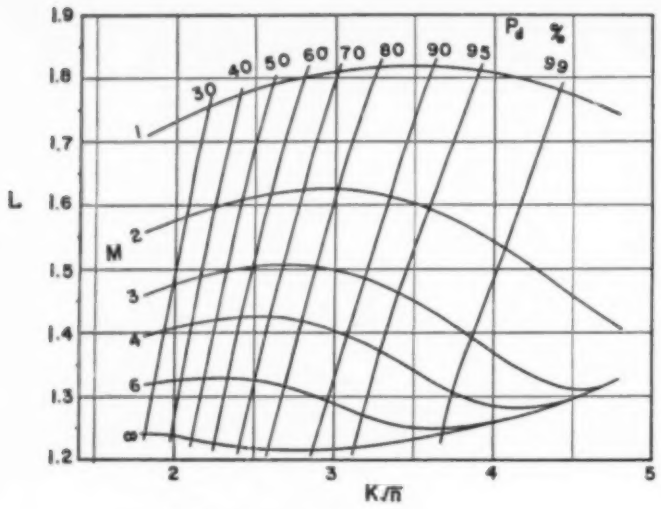


Figure 3—L vs. $K\sqrt{n}$ for Values of M and P_d

interval when the process average has shifted to $\bar{\bar{x}} \pm K\sigma'_{\bar{x}}$. Values for this quantity are obtainable from Fig. 5.

Example 4

Again, for the data of Example 1 with $P_d = 95$ percent we enter Fig. 5 with $K\sqrt{n} = 1.5\sqrt{5} = 3.36$ and read $I_K/P_d = 0.0156$. Then $I_K = 0.0156 \times 95 = 1.48$ samples, or $1.48 \times 5 = 7.4$ pieces inspected per sampling interval when the process average is a $\bar{\bar{x}} \pm 1.5\,\sigma'_{\bar{x}}$.

The corresponding figures for Example 2 are $K\sqrt{n} = 3$, $I_K/P_d = 0.0200$, and $I_K = 0.0200 \times 92 = 1.84$. The average number of pieces inspected per sampling interval is, then, $1.84 \times 4 = 7.36$.

It is interesting to note the relatively small sample sizes and average number of pieces inspected in the above examples. These values would, however, be considerably increased for smaller values of K and/or larger values of P_d. On the other hand, the values could be reduced by increasing M. The relative efficiency of the warning-limit charts will become more apparent in the next section where we compare them with conventional $\bar{x}$ charts without warning limits.

Evaluation of Optimal Solution

Two questions may be legitimately posed at this point: "Does it pay to use a warning-limit chart?" and "Does it pay to use the optimal solution?" The answers are rather unqualifiedly, "Yes!" if the evaluation is based on the average amount of sampling required to yield a specified protection.

Consider a warning-limit chart with sample size n and total pieces inspected per sampling interval $= n \times I_o$; we suppose that there is a probability P_d of detecting a shift of $K\,\sigma'_{\bar{x}}$ in the process average. For comparison, choose a conventional $\bar{x}$ chart (without warning limits) with a sample size N chosen so as to yield the same probability P_d of detecting the same shift of $K\,\sigma'_{\bar{x}}$ in the process average. Then $R = [N/(n \times I_o)] - 1 \times 100$ gives the percentage increase in the average amount of inspection required by the conventional $\bar{x}$ chart as compared to the chart with warning limits. Figure 6 gives a plot of R vs. P_d for various values of M (from one to ∞) using optimal solutions for the warning-limit charts. It is seen that the percentage increase in the amount of inspection can become quite significant. For the data of Example 1 the conventional chart requires a sample size of ten—a 67 percent increase in the average amount of inspection.

In comparing conventional and warning-limit charts, there is one other factor which should be evaluated — the number of "false alarms" given by the chart. The probability of a "false alarm" is the probability that the chart will indicate a change in the process average when in fact the process remains in control (this is the Type I or α error of sampling theory). For a conventional chart with $3\sigma'$ limits the probability of a false alarm is 0.26 percent. For an optimal warning-limit chart the probability will not exceed about 0.34 percent—certainly a negligible increase. We may conclude then that both types of charts have about the same false alarm rate (roughly three out of 1000).

How important is it to use the optimal solution? The answer clearly depends on the amount of the deviation from the optimal solution, and so no general answer can be given. However, the following example is indicative of the kind of results which might be expected.

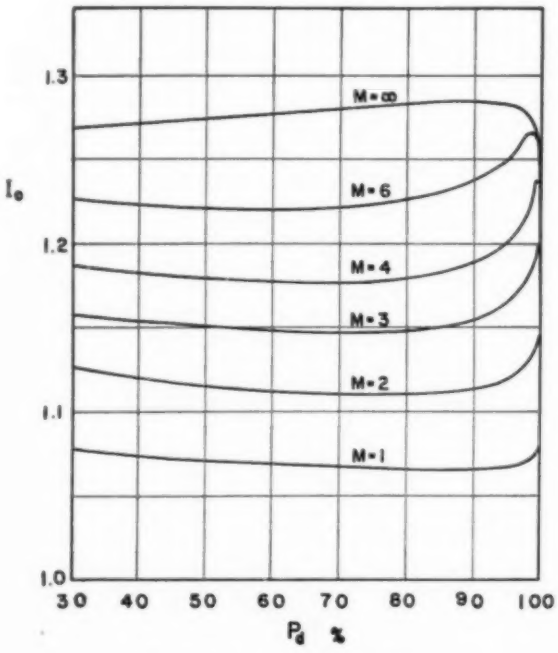


Figure 4—I_o vs. P_d for Values of M

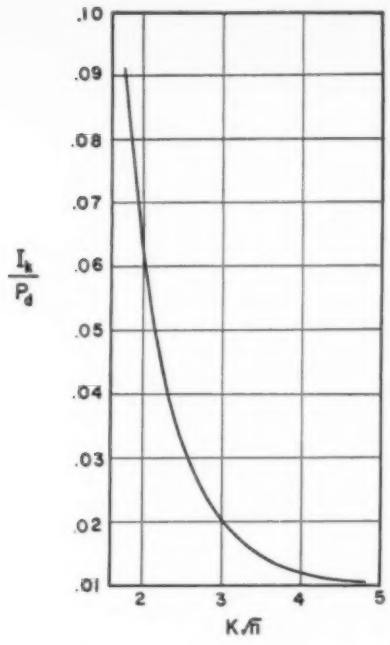


Figure 5—I_K/P_d vs. $K\sqrt{n}$

Example 5

As in Example 1, let $K = 1.5$ and let P_d be at least 95 percent. Because of their rather common use, we shall employ "two sigma" warning limits. To get a P_d of at least 95 percent will require a sample size $n = 7$. The average number of pieces inspected per sampling interval turns out to be 7.31, a 20 percent increase over the amount of sampling required by the optimal chart.

Conclusions

$\bar{X}$ charts with optimally placed warning limits are extremely simple to construct and to use. When compared to conventional $\bar{x}$ charts or non-optimal warning charts, they permit very substantial reductions in the amount of inspection required while maintaining the desired level of protection against undetected shifts in the process average.

Mathematical Appendix

Consider an M-stage warning-limit chart with sample size n and warning limits located at $\bar{\bar{x}} \pm L\,\sigma'_{\bar{x}}$ (control limits are placed at $\bar{\bar{x}} \pm 3\,\sigma'_{\bar{x}}$). Suppose that the process mean $\bar{x}' = \bar{\bar{x}} + K\,\sigma'_{\bar{x}}$ (with $\sigma'_{\bar{x}}$ constant). Let $u = K\sqrt{n}$ and

$$P_S(K) = \int_{t=-L-u}^{L-u} f(t)\,dt \qquad (1)$$

$$P_W(K) = \int_{t=-3-u}^{-L-u} f(t)\,dt + \int_{t=L-u}^{3-u} f(t)\,dt \qquad (2)$$

$$P_A(K) = \int_{t=-\infty}^{-3-u} f(t)\,dt + \int_{t=3-u}^{\infty} f(t)\,dt \qquad (3)$$

where $f(t) = (\exp - t^2/2)\sqrt{2\pi}$

Then the probability, $P_d(K)$, of detecting the change in the process mean is

$$P_d(K) = P_A(K) \sum_{r=0}^{M} P_W(K)^r = \frac{P_A(K)[1 - P_W(K)^{M+1}]}{1 - P_W(K)} \qquad (4)$$

and the expected number of samples inspected, I_K, is given by

$$I_K = [1 - P_W(K)] + 2\,P_W(K)\,[1 - P_W(K)] + \ldots + M\,P_W(K)^{M-1}[1 - P_W(K)] + (M+1)\,P_W(K)^M = \frac{1 - P_W(K)^{M+1}}{1 - P_W(K)} \qquad (5)$$

The problem is to find the values of L and u which minimize nI_o, subject to the restraint $P_d(K) = \text{constant}$ for some given $K \neq 0$. The solution is obtained by Lagrange's method of undetermined multipliers. The Lagrangian function is

$$Q(L,u) = nI_o - \lambda\,P_d(K) \qquad (6)$$

where λ is the Lagrangian multiplier. Necessary (and in this case, sufficient) conditions for achieving the constrained minimum are

$$\partial Q/\partial L = 0,\ \partial^2 Q/\partial L^2 \geqq 0,\quad \partial Q/\partial u = 0,\ \text{and}\ \partial^2 Q/\partial u^2 \geqq 0, \qquad (7)$$

subject to the restraint $P_d(K) = \text{const.}$

Eliminating λ from between the two first partial derivatives, we obtain the following equation for solution:

$$\frac{[f(3-u) - f(-3-u)] \sum_{r=0}^{M} P_W(K)^r + [f(L-u) - f(-L-u) - f(3-u) + f(-3-u)]\,P_A(K) \sum_{r=0}^{M} rP_W(K)^{r-1}}{(1/u)[f(L-u) + f(-L-u)]\,P_A(K) \sum_{r=0}^{M} rP_W(K)^{r-1}} = \frac{\sum_{r=0}^{M} P_W(0)^r}{[f(L)] \sum_{r=0}^{M} rP_W(0)^{r-1}} \qquad (8)$$

Using the facts that the right hand side of (8) is independent of u and that the summations are simple recursive relations (in M), solutions to (8) were computed with the aid of a Burrough's E-101 computer using iterative procedures. From the triples [M, L, u] satisfying (8), the corresponding values of $P_d(K)$ and I_o were computed from (4) and (5). The comparison of conventional and warning-limit charts was made with data obtained rather directly from tabular entries generated in the course of solving (8).

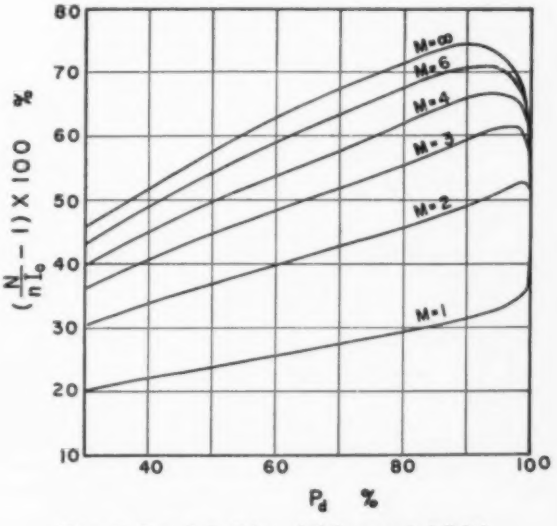


Figure 6—R vs. P_d for Values of M (from one to infinity)

PROFESSIONALISM AND THE UNIVERSITY

ELLIS R. OTT, *Rutgers • The State University, New Brunswick, N.J.*

OUR SOCIETY now has more than 13,000 members—members who sometimes act as if they were divided into three mutually exclusive camps. One camp might be called the Management-Engineering Camp; another The Experimental Methods in Research and Development Camp, and the third The Applied and Theoretical Statistics Camp: Each camp hopes to maintain cordial relations with the others — it is felt that they may add a certain aura of professional status — but each camp wants careful safeguards to prevent contamination from the others. There is a large meadow between the camps — whose chief characteristic is that it is largely uninhabited. It is considered by some to be an undesirable neighborhood.

I want to discuss with you whether it is important to develop this meadowland into one which can be considered respectable and habitable by a merging of the three camps, and then a possible role of universities in a cooperative effort to colonize the meadow with professionals and possibly to modify each of the three camps a little.

You may have an interest as one who would like to develop a career as a professional in this field; or it may be as one who has a need to employ professionals.

SQC Professionals

For want of a better phrase, we will call those persons working in one or more of the three camps an *SQC Professional*—we accept the inadequacy of this term and any of the others we have heard. Subtitles include: Quality Control Manager, Quality Control Engineer, Reliability Engineer, Quality Control Consultant, Applied Statistician, Theoretical Statistician, and Quality Control Practitioner. Few people can claim competence in all of these functions. You may have other terms and other functions you would include, and it is not my interest to insist on the ones just given.

ASQC LCS Code 000:00:000

Ellis R. Ott

ASQC

SHEWHART MEDALIST

For 1960

Changing Times

Fifteen years ago, I would call friends in neighboring industries to ask whether they had positions open for graduate students in quality control and applied statistics. The answer was sometimes "yes" and often it was "no." Although the use of these methods was accepted reasonably well by the electronics industry, other industries had not been forced to use them in the same way (by the Government) in purchases of defense equipment. For example, the chemical industry at that time considered suggestions to try the science of statistical methods to be a reflection upon their professional competence. A similar reaction has existed in all industries, continues to exist, and probably should be expected to exist; we can expect to hear again and again the old cliche—it won't work for us!

But just a few short years later —about 1952—we were receiving an increasing number of phone calls and letters asking about available professionals in such numbers that the demand exceeded the supply. We then began to advise neighboring research and development groups to select some of their bright young researchers (chemists, chem-engineers, engineers) and send them to us for graduate training in applied statistics; this seemed the only practical solution to the personnel problems in this new field. The gap between demand and supply is increasing, and this is our continuing forecast. It's not often that we in the universities have knowledge of available students trained or experienced in the design of experiments—or the analysis of data collection and analysis—or possessed of any substantial competence to couple the formal statistical training with applications in the field of science or engineering—or to organize and direct a modern statistical quality control program. Telephone calls come from surprisingly long distances to tell us of splendid openings for a competent young man or woman. This is exciting—it is gratifying—it is sobering to us in the universities—and perhaps it should also be sobering to you.

Visiting Teams

There has been progress in developing both the extent and the variety of industrial applications of statistics and SQC; however, the record indicates there are relatively few companies whose SQC programs can be considered more than

a beginning toward a satisfactory program of quality control, and not many show appreciable progress.

During the last six or seven years, there have been teams from several industrially - conscious countries visiting the USA to discuss our approach to SQC, and to visit plants using modern quality control systems: one from Europe, one from Denmark; one from Spain; one from Japan; one from Korea, and one arrives this month from India.

I might ask whether you would recommend that they visit one of your plants? And if they did, many of them would tell you frankly and honestly that they have an equally good or better program in their own country. While it's true that our industrial applications of SQC are more advanced than in any other country—with the possible exception of Japan—they are disturbingly inadequate. There are different reasons for this, but a major reason, in my opinion, is a scarcity of men — appropriately trained — who can activate and direct such programs and obtain necessary organizational status. Short courses in quality control management, quality control engineering, or statistical methods all are useful—we need more of them. But they are auxilliary to the training of professionals.

We have always had a two-cycle advance in SQC, alternating between our efforts to interest management and our efforts to provi professionals and practitioners who can produce results for them. The development of management's interest will continue to warrant attention, but unless we develop more and better professionals, we will face the likelihood of disappointing management and in losing ground already gained. Have you ever talked to management representatives who have tried what was called "quality control" and who didn't like it?—they are now going to be slow to give even an improved program another chance. There is an old phrase, "it pays to advertise—if you've got the goods." Do we have either the design or the production facilities to produce the goods?

What's the Job?

If we are to develop an SQC professional; one out between the three camps—what is his problem? What is his job?

One job-description relates to the industrial functions requiring his attention: customer interests; research and development; design and specification; manufacture (produce); process improvement; inspection (testing); quality assurance (reliability); and management's provision for their direction and integration. Some of these functions are more important in one industry than in another, and more so in one plant than another.

Whether these functions are centralized in one staff or line organization—or several—is not vital provided their integration is assured.

A second description relates to seven functions to be performed by our professionals. He should know

1. How to locate (identify) an opportunity with economic potential
2. How to plan an exploratory study—including the type of data to be collected and the manner of collecting it
3. How to collect the data, or supervise its collection
4. How to analyze the data (This has received major attention from statisticians)
5. How to interpret the data and to check whether the interpretation agrees with the state of the science and of manufacturing, and whether the data even warrants an analysis and interpretation.

Note Data from a study or an experiment should provide three things:

   (a) An evaluation of the experimentally indicated statistical significance for the factors included

   (b) An evaluation of the magnitude of the effects to permit a practical evaluation and comparison of the factors, and

   (c) Suggestions of relations or ideas not included in the hypothesis of the experiment, i.e., discovery

6. How to convince appropriate personnel of the interpretation. The purpose of an industrial study is to provide a *basis for action*, and the practitioner has not been successful in his task until the results of the study have been understood by those in position to make decisions and authorize action
7. How to provide a continuing control — many problems are solved "in principle" but recur again and again because inadequate continuing controls are provided.

The order of these seven functions is not necessarily vital; in fact, sub-cycles of these functions will be frequent. Although many important books and articles have been written on statistical methods of analyzing data already in hand, inadequate attention and research has been devoted to developing statistical techniques pertaining to the other functions listed above. This is an important form of research warranting high priority from our professionals.

Is It Possible?

Is it possible to train professionals in these seven associated functions? Some of my friends think it is, some think it isn't; it's certainly not an easy assignment. Consequently, it's easy to yield to the temptation to educate in statistical theory and in mathematics rather than face up to the vital education that's needed.

There are some who argue that it is adequate to teach the principles and theory of a science and assume that the applications will follow naturally or can be developed by the individual when needed. Possibly there are sciences where this is realized adequately; it is my own experience with students in applied and mathematical statistics—students employed in a wide variety of industries—large, medium, and small—that this is not an appropriate philosophy with respect to our own science of statistical quality control. Theory and application must be coupled from the very beginning if we are to develop logical processes of reasoning and decision making.

Scientific Method and Statistics

I believe that anyone who hopes to apply an analytical (systematic reasoning) approach across the functions listed above is assisted critically and immeasurably by competence in three things:

(a) A competence in statistical understanding, ingenuity, and skill in techniques

(b) a competence in recognizing opportunities for their use

(c) a competence in attaining cooperation and follow-through of findings.

It is not easy to develop these three functions but it is basic to

the attainment of the long-term goal of professionalism in SQC. We (in ASQC) are now developing Society leadership in various aspects of professional development by our Education and Training Institute. This is vitally important and it was the appropriate way to get underway. But it is now time to consider whether our own efforts in ASQC can ever be adequate. The problem of developing SQC professionals in kind and in quantity is a major assignment; it warrants top priority in our efforts and should be approached by every promising method.

Universities

In my opinion, the universities must be considered the long-range hope of professional status: the role of colleges and universities in all established professions is a matter of record. It would be comforting if I could say to you, " universities are willing and able to help" —but it just isn't so! There are serious problems to be solved if universities are to provide more than token support in developing professionals and profesisonalism in SQC. If you agree on the appropriateness of developing the seven preceding functions—even agree as much as 50 percent—then quality control and statistics can receive increasing support from the universities provided we first give the universities certain support. There are some universities, of course, with undergraduate and graduate programs in management. There are also universities teaching statistics, usually as a form of mathematics—but there is a tremendous and increasing shortage of statistically trained persons at all levels. Then how might we develop more universities which will coordinate the education in two, or three, of the camps mentioned previously—or even one of them, for all that?

Possible University Programs

There are five types of university sponsored programs which show promise of importance in developing SQC professionals:

1. Undergraduate sequences in the principles and methods of statistics (as opposed to the mathematics of statistics). This is almost essential for all natural sciences — biology, chemistry, physics, agriculture, pharmacy, engineering, and mathematics. A steady increase in the teaching of some statistics to undergraduate engineers is already progressing; but it seems poor strategy to wait for undergraduate degrees in quality control engineering — for various but compelling reasons.
2. A Master's degree program in engineering to include a sequence of two or more courses in statistical methods and principles.
3. A graduate Master's program in Business (or Business Administration) with a minor in statistics, and vice versa.
4. A graduate Master's program in Applied and Mathematical Statistics for college graduates who have majored in engineering, science, or mathematics on either a part-time or full-time basis. Their graduate program can include a combination of statistical and management principles, with both theory and applications.
5. A graduate Ph.D. program in statistical methods, principles, applications, theory, philosophy and research.

Role of a University

What might ASQC expect from a University? — with "encouragement"—or without it?

The problem is comparable to the one of developing SQC within a plant or industry. In a very few plants, the president or some other top-management official says "set up a program!" — in most companies, however, the SQC professional proceeds under his own initiative. Similarly, new programs in universities are usually developed because of the interest of certain professors, and thus it is important for SQC professionalism to interest more professors.

An expanding series of university graduate programs across the country, especially in the patterns of #4 and #5 above is a reasonable goal—if planning begins now.

Within each university, there will be many problems to face, usually simultaneously, with a continual adjustment and readjustment of priority:

First, course content; notes and texts; sequence of courses and sets of notes. Notes and texts for many courses in theoretical statistics are available—more are needed and will be forthcoming. But the prospect of similar books and notes on the non-statistical aspects — and how to make statistics a part of an educated reasoning mind — this being in the meadowland between the three camps — is not promising. The organization of such methods and principles will be an important contribution to the universities if they are to assist in graduating professionals.

Second, internal support from the university administration — every new program in a university costs much more than income from tuition. There is never enough money for those curricula already being offered, and authorization for each new one requires convincing evidence of its importance. Is this any different from the difficulties in industry of convincing management of the value of a new product-line or department? Without administration support, little progress is possible. If professionals in the industrial applications of statistics are needed by industry, then let the universities know about it convincingly.

You think you have problems—consider ours—or possibly they are just yours! You have heard of the population-explosion in applications for admission to colleges. Rutgers, for example, began planning for a doubling of applications by 1965, and a like increase five years later; "expecting twins by 1965, the news now is to expect triplets." Other state universities are making similar plans for major increases in the acceptance of students. It is often thought to help by sending students. Good students are welcome! But there is no shortage of undergraduate students nor even graduate students.

Third, the shortage is in: (1) Faculty, both teaching and research; (2) physical facilities; and (3) finances—usually in a rotating order. Few legislatures can be expected to supply funds—especially to new programs—except "to little and too late." Industry must face the alternatives: (1) of a continually increasing shortage of trained personnel: (2) of increased support directly to university programs of their interest, or (3) of increased taxes.

Fourth, development of an appropriate faculty—a full-time staff is essential to the development of any university program, and it is critical for SQC and statistics. Many of you will agree that pro-

fessors in statistics and SQC should be competent and interested in applications to science and industry. This interest is important in the education of the students: statistics has been a routine set of techniques too often.

The professor should also be interested in students and in teaching. There is a delicate balance here since we need as college professors just those persons with the qualifications to be successful practitioners and managers in industry—persons who teach because of a desire and not because they have no alternative. I might ask: "What kind of professors do *you* want us to have?" One solution (in SQC) is to encourage the combination of a professorial appointment with a modest amount of industrial consulting—this can give vitality in the classroom and provide a stimulant for research from the industrial experiences.

The shortage of faculty in statistics is even more serious than in mathematics and physics; and it is almost impossible to find a professor with interest and competence in the broader field of SQC professionalism.

In some industrial centers in the U.S., it is possible to augment the full-time staff with exceptionally competent instructors on a part-time basis from neighboring industries.

Fifth, acceptance by other departments of the university — faculties give a critical evaluation of new curricula being proposed. They want to know if they are really different from existing ones; and if different, is this a good thing?

Sixth, is our American Society for Quality Control interested in Ph.D.'s? The answer is related to the future role of universities in the development of professionalism. An appointment to a university faculty requires an interest in teaching and research which is (or should be) included in a Ph.D. program; this then is the principal source of a faculty for any field of professionalism. Acceptance by other departments requires a faculty holding Ph.D. degrees and this is extending even to schools of engineering which have been an exception to the rule.

There is also an unsatisfied demand for many of you in industrial research organizations for Ph.D.'s competent to make industrial applications of statistics — and you are tempted to offer high salaries to those who would otherwise educate succeeding generations of SQC professionals.

There are some 50 new Ph.D.'s a year in statistics—whether or not trained in theory alone—and this is only a fraction of the demand from colleges—and from industry —and from the Government.

Industry Support

Are you familiar with the recently - announced, "Cleveland Plan"? Twenty-one Cleveland companies have agreed to give a minimum of one percent of net income before taxes to higher education for the next three years, and to increase the percentage thereafter. Each company is free to give to projects and colleges of its choice. The plan has stimulated wide interest and civic-minded managers in other cities."

Alumni gift-matching — see "*Changing Times*," June 1961, p. 32: "Your donation is only a small part of what your college needs from you in the way of help. It wants your political support, too. As a college graduate you have an important influence on national as well as local affairs . . . The more you know about your college and its many problems — e.g., the difficulty of getting teachers, the need for science facilities—the more you will know about the problems of other colleges . . ."

Merit scholarships for children of employees with an accompanying grant to the college of their choice.

The Bell Laboratory's new plan combines several features:

1. releases staff from duties one day a week to attend graduate classes, and
2. when within one year of completing a Ph.D., a year's leave of absence with full salary, *and*
3. what is equally vital: a payment of $2500 to the university department directing the graduate work of the employee.

Our Rutgers program in Applied and Mathematical Statistics was given initial support, both financially and advisory, by some 20 neighboring industries. Without it, we might or might not have made progress — certainly, the support provided a major impetus at a critical period.

The American Society for Quality Control — and industry — can have an influence in an expanding and improving series of university programs if so inclined, especially at the graduate level. The need for increased numbers of Ph.D.'s is critical to the development of professionalism.

Fellowships, particularly those which encourage the development of college professors, is one way of enlisting university support. It isn't a question of whether industry can afford it—it is a question of whether it can afford not to.

In Conclusion

It is difficult to discuss the development of professionalism by universities without the risk of appearing, on the one hand, to be playing the role of the poor cousin in need of old clothes or what have you—or on the other hand, of seeming to be chiding. Neither role has been intended and I hope not inferred.

Some universities have a nucleus of professors who are ready and willing to help in the development of professionals but this is a long way from the goal. Our Society has made important progress recently both in formulating the role of a professional in SQC and in accepting leadership in certain phases of the education and training of our Society's membership. I believe that it is now vital to enlist increasingly the academic support of our universities to the support of one of the three camps, or two of them, or best of all to colonizing the meadowland between. Little can be expected without a conscious effort.

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COMMUNICATION–EDUCATION–AUTOMATION

WADE R. WEAVER

Republic Steel Corp., Cleveland, Ohio

THE SOCIETY has seen fit to bestow upon me one of the highest honors which it is privileged to grant. To say that I am grateful, that I am humble, that I am inordinately proud to have been designated for this great honor, is merely to emphasize my inability to find the words to express my sincere thanks. The honor of being the recipient of a medal created to honor a close personal friend for many years, George D. Edwards, is completely boundless. To you who have seen fit to so honor me, I am eternally grateful.

As many of you know, I am often categorized, affectionately and otherwise, as "one of the old fogies." I herewith plead guilty as charged. But, this also carries some privileges, among which is that of being permitted to offer some observations on occasion. As a founding member of ASQC and, in fact, one of the organizing members, I have been privileged to both observe and experience considerably more of the origin, growth, and development of our Society than most of you. I hope this entitles me to pass on to you some of my considered observations and thoughts. These are offered purely constructively, in the hope that they may prove to be of helpful guidance.

I should like to offer a few comments on "COMMEDUMATION"—a synthesis of (1) communication, (2) education, and (3) automation. I believe these three areas to be of signal importance to our Society. Communication is our greatest problem; communication among ourselves regarding our policies and objectives and their implementation, our internal management, our ideals, our ethics;

ASQC LCS Code 000:00:000

Wade R. Weaver

ASQC

EDWARDS MEDALIST

For 1960

and the communication of all phases of our chosen field to others outside that field.

Activities by special interest groups, such as the various Divisions of the Society, have unquestioned merit. But such unilateral action also can have destructive results unless the natural tendency to "pull apart" is carefully constrained and "pulling together" is retained. In any event, the existence of these groups has drastically increased the problem of communications. ASQC has grown so phenomenally fast in so many different directions that we have been unable to keep abreast with our communication lines. Great progress has been made in the past two or three years, but the need of much, much more is imperative.

A majority of our members do not seem to understand that ours is a professional society, or at least do not seem to realize just what professionalism implies. The void between our Society and the commonplace trade association or commercial society is vast. A considerable number among our membership seem to think we are a "standardizing body" of some sort. We definitely are not. If we are to attain the position of prestige in our chosen field which we seek and merit, we must always have true professionalism firmly in mind. Much has been done within the past two years to advance the understanding within the Society of this concept. Commercialism in any form is not compatible with professionalism. We must take carefully and thoughtfully, but firmly, those steps which will enhance the image of our Society in its professional field. This requires extensive communication among the varied elements and groups of the Society, and particularly with the individual members themselves. This is a challenge which we must not only recognize, but meet and solve.

Education has always played a vital role in our activities, in our development and progress, and it always shall. We have been fortunate in having had many fine educators associated intimately with many of our activities. But the burgeoning demand has seemed to have outstripped the supply, particularly at the more sophisticated levels. Recent formalized action on the part of the Society in establishing high level training

seminars has commenced to fill a recognized vacuum and has met with rewarding success. Much more of this needs to be done and will be done.

"Education" covers more than mere technical training. Of equal importance is the development of professional character, the appreciation for the highest possible ethical standards, and principles of sound management. These precepts must also be available to the members as rounding out their "education."

Communication itself plays a very great part in the field of education. Professional educators and educational institutions all too often seem woefully unaware of the particularized requirements of various industries with respect to formal training in SQC. Once the basic and intermediate techniques have been presented the student is supposed to be "accomplished," but sufficient thought has not been given to enabling him to become reasonably expert in any specific line of endeavor. The series of seminars tailored specifically to the chemical industry offered by the Rochester Institute of Technology is typical of what seems to be in great demand, but in very short supply. Educational institutions should recognize the severe impact which Quality Control is having on all industry. To fulfill their obligations, they should provide the type of curricula which industry demands. Much improved liaison and better communication with industry are required in order that industry's needs can be provided.

Better communications can lead to better education, and both are vital to the growth of professionalism in our field. Better and faster methods of imparting knowledge to the would-be Quality Control Engineer must be found. Industry simply cannot wait several years to "make their own men." This must be done for them by experts. The problem is advanced herewith as a challenge to the educators within our Society.

Automation is a generic term which is currently being used quite widely, frequently quite loosely, and its implications are extremely broad. In certain areas it is a "dirty word"; in others it has completely revolutionized almost an entire industry. While its general meaning may be understood rather well, it is all too obvious that there are certain elements which are almost universally unappreciated. The success of the control of many modern automated processes depends upon the generation of process data which can be quickly analyzed and fed back to activate control mechanisms, or serve as guides to prompt corrective action.

The development of many types of computers has been much more rapid than the training of people to utilize them. Attempts to apply these fantastic machines to industrial processes is progressing by leaps and bounds. Meanwhile, the preparations for reducing and analyzing the data generated by the automated process, and its review, interpretation, and utilization by trained experts, is proceeding at the veritable snail's pace. Because I am so firmly convinced that industry's progress is being throttled by a severe shortage of man-power specially trained for such duties I strongly urge that high priority be given to the development of techniques for training people in this specific area. I do not refer to machine operators, programmers, etc., but to the individuals who can tell the programmers what to do, then usefully interpret the results of the data analysis and initiate corrective action. There is a great dearth among those who choose to class themselves as Quality Control Engineers of individuals who have more than a faint conception of what Automation means to them. Certain specific QC techniques are of particular value in studying automatic systems. Pitfalls exist by the dozen for the untrained individual. The rewards for success are high, failures are disastrous. I firmly believe this rapidly developing area to be something which will have a tremendous impact upon our chosen field. We must meet the challenge. Already there are broad indications that others will be quick to "take over" if we fail. We cannot afford to fail.

Communication — Education — Automation; these three are destined to play vital roles in the continued growth and development of our Society and of its individual members over the forseeable future.

Thank you for this opportunity to advance a few old fogey ideas, and my sincere thanks for the high honor which has made this occasion possible.

REVIEW

Quality Control

METHODS

AND

MANAGEMENT

THROUGH THE

Third and Fourth

Annual Symposium

TRANSACTIONS

These Symposia were conducted at the Drexel Institute in 1958 and at Temple University in 1959 by the Philadelphia Section, ASQC.

THIRD SYMPOSIUM TRANSACTIONS—$2.00

The Purchasing Agent Looks at Quality Control
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QUALITY CONTROL IN THE QUAKER CITY . . .

Report of the 15th Annual Convention and Exhibit

The 15th Annual Convention and Exhibit of the American Society for Quality Control officially started on Monday, June 5. By this time many of those attending the convention had already spent many enjoyable hours in Philadelphia, the Quaker City.

Reception

At the pre-convention social, everyone seemed to be having such an enjoyable time renewing old acquaintances that many did not realize this was a "dry" affair. The Philadelphia laws limited the beverages to soft drinks and coffee. Judging from the attendance and volume of conversation, the spirit of friendship in such a group is much more important for a relaxed evening than the spirits which are usually dispensed in a glass.

Registration

Those who arrived at the Sheraton Hotel early found complete registration facilities in operation starting Sunday afternoon. Approximately 370 of the early arrivals completed their registration Sunday before 8 p.m. Monday morning found a large staff of registration clerks ready at their booths to process advanced and on the spot registration with a minimum of delay. When the unofficial counts were made, registration for the 15th Annual Convention totaled 2733. This is the largest attendance at an ASQC Annual Meeting. The 1953 Convention, in Philadelphia, holds the second-place record with a total registration of over 2,600.

Ladies Program

More than 100 ladies signed up for the ladies program which included tours of Historical Philadelphia, Antique Row and leading women's shops. The fashion show, held at the Sheraton Hotel, was a success for the ladies but proved to be distracting for the men. Because of a miscalculation concerning the acoustics, the descriptions of models in bathing suits filtered into one of the technical sessions. For a time, it appeared that those in the technical session would transfer to the fashion show before the hotel electrician could make corrections.

Convention Program

The convention program this year was perhaps the most ambitious ever attempted for a three day meeting. Julius Mehalek, the convention chairman, welcomed the group at the General Assembly which convened Monday at 9 a.m. A certificate from the City of Philadelphia was awarded which proclaimed June 4-10 as "Quality Control Week in Philadelphia."

The annual meeting of the Society was conducted by President McClure during this General Assembly. The 1960-61 officers presented reports on activities during the past year. The sincerity and plain hard work on the part of these officers could be seen as the reason for the success which the Society has enjoyed during the year which has just been completed. The printed Annual Report of the Society for this year has been given the new look, compact and very easy reading.

President McClure announced the results of the Saddoris Award for Section Management. The section with most points gained through its activities during the past year was Los Angeles. The award was accepted by the section chairman, E. J. Lancaster. The only Master section, having scored 75 percent or greater of the points accumulated by the winning section, was Northeast Tennessee.

Following the first General Assembly on Monday morning, the technical sessions began. The program consisted of two portions, the main convention sessions and the "Inspectioneering Workshop." During the three days there were 80 topics covered by 111 speakers as part of the main program. The "Inspectioneering Workshop" was made up of 15 sessions during the three days with 32 speakers. The quality of the program was substantiated by the large attendance each session enjoyed. The Sheraton Hotel facilities were very comfortable and adequate. The program committee deserves high praise for the work they did on behalf of the membership this year. There were topics of interest for all levels of application of Quality Control Techniques. Presentations ranged from "Statistics Made Easy For Inspectors" given by Stanley Wirtschafter of U. S. Gauge Division, American Machine and Metals Inc., to "A Stratified Systematic Sub-Sample Plan Selected and Evaluated on a Digital Computer" by S. A. Troxel, Ohio Bell Telephone, Cleveland, Ohio. Most of those attending found it difficult to make a selection between the excellent papers which were being presented in the seven concurrent sessions. One of the most unusual subjects was "Quality Control Techniques in Casino Operations" by Charles Hirsch, The Golden Nugget, Las Vegas, Nev. Mr. Hirsch spoke to a capacity audience, all of whom thought there must be a "system."

Annual Banquet

On Tuesday evening, approximately 900 members and their guests attended the Annual Banquet of the Society. The banquet

Annual Banquet speaker, James N. Davis, center, deputy assistant secretary of defense for production management, is shown with A. V. Feigenbaum, left, president elect, ASQC, and J. Y. McClure, president, ASQC. Mr. Davis presented "Reliability—Where Do We Go From Here?"

this year was held in the Grand Ballroom of the Sheraton Hotel. Following an excellent meal, President McClure reconvened the Annual Meeting so that Karl Bauer, Chairman of the Tellers Committee, could present the results of a very close balloting for Society officers. The elections this year were so close that the Tellers Committee could not complete its tabulations in time for announcement of results at the Monday morning General Assembly as originally planned.

The incoming officers of the Society were introduced by President McClure. (See pages 32-33, of this issue.) President elect A. V. Feigenbaum spoke briefly to the members and judging from his remarks of acceptance the Society can look to 1961-62 as another outstanding year of growth and development.

President McClure then introduced Paul S. Olmstead, sponsor for the Shewhart Medalist, who presented the Medalist with the following remarks:

Being selected as the sponsor of a Shewhart Medalist is an honor not to be taken lightly. However, I found it hard to believe that this year's medalist, in his letter of acceptance, would refer to me as one, "who has been almost like a father to me in my work." This obvious overstatement, though it does suggest a willingness to listen to criticism, does not indicate that he has been a crusader for the cause of statistical quality control. How did this happen?

His boyhood was typical of Whittier's "Barefoot Boy" and Mark Twain's "Tom Sawyer." I am told that he helped himself through school by such odd jobs as working in a grocery store, assisting the manual training teacher, helping lay a pipe line, typing, and many more. In fact, one might guess that he had read all of the Horatio Alger books and made use of all the ideas suggested therein.

Born in Dexter, Kans., he obtained his A. B. from Southwestern College and his M. A. from the University of Kansas. He then became an instructor at the University of Illinois and started work toward a Ph. D. in mathematics. Perhaps his first exposure to the theory of probability occurred here when he met a lovely coed on a blind date. She was his wife-to-be. After a year at the University of Arkansas and his Ph. D. from Illinois in 1933, his next stop was the University of Buffalo. It was here, as you know, that Dr. Martin A. Brumbaugh, Shewhart Medalist for 1950, started publishing *Industrial Quality Control* in 1944. By this time, interest in college algebra had been replaced by a stronger interest in statistical quality control.

In May 1944, he became executive engineer in charge of statistical quality control for the National Union Radio Corporation in Newark, N. J., temporarily forsaking his island campsite in the Adirondacks. After a brief stay in 1946 as Assistant Dean at Buffalo, we find him Chairman of the Department of Mathematics for Rutgers' University College. One of his first steps was to schedule a course in statistical quality control. Next, he organized the first Rutgers Conference Series on Quality Control. He cooperated with the Metropolitan Section in organizing the first Rutgers all-day conference. Soon after this, the first program leading to a Master's Degree was established for the field of quality control and industrial statistics. When course enrolments had soared to over 500 per year, it was clear that a Ph. D. program was needed. Quality control and statistics were now so important in Rutgers that a Statistics Center became a necessity. Is it any wonder that the Dean of the Graduate School refers to the man responsible for this as a missionary for statistical quality control?

Time is too short to indicate here his specific contributions to theory, his important part in guiding the development of ASQC, or even the spread of his reputation to foreign lands. These will be recounted tomorrow. So, without further ado, I would like to read the citation for this year's medalist and present to you, Mr. President, and this audience the Shewhart Medalist for 1960, Dr. Ellis Raymond Ott.

His citation, as prepared by the Shewhart Medal Committee, reads as follows:

"The Shewhart Medal established by the American Society for Quality Control for outstanding leadership in the field of modern quality control is awarded to Ellis Raymond Ott for the year 1960 in recognition of his leadership in the development and administration of a university graduate program in quality control and applied statistics; his inspirational approach in teaching students and others how to make effective practical use of quality control techniques; his contributions to simplified statistical methods for the analysis of data; and his many activities in promoting wider use and a better understanding of quality control as a profession, not only in this country but also abroad, especially in India.

Prof. Ott responded with the following remarks:

It isn't possible for me to express my pleasure adequately in accepting the Walter Shewhart award. This award of our society will be cherished by me for several reasons—but particularly because of the continuing reminder of the advice and encouragement Dr. Shewhart has given me over the last fifteen years both as a friend and as an Honorary Professor and advisor to our graduate program at Rutgers; he has been a source of inspiration both personally and professionally.

It would be in poor taste for anyone to extol the quality of his writings — they are the primary standard. But it may be appropriate to remind you that his book, *The Economic Control of Quality*, written just thirty years ago, is still available and is marvelously stimulating. Not everyone reads the writings of Walter Shewhart adequately.

Some six or seven years ago, Dr. Shewhart loaned me his famous Shewhart bowl which he used in his famous chip-drawing experiments—it is a simple, yellow, kitchen mixing bowl. I took it to one of my classes then, being very careful of it. Then a few days ago in talking with him

(Please turn to page 30)

15th annual CONVENTION

Reading from upper left:

For outstanding achievement in the manag[illegible]ent of
Award Plaque to Jack Lancaster, chairman, Los An[illegible]
Wade R. Weaver, Fellow, ASQC, of Republic [illegible]teel Co[illegible]
the second year of presentation of the Me[illegible] which
of the quality control profession. It is a[illegible]ded for
quality control.

J. Y. McClure presents the Brumbaugh Awa[illegible] to Ric[illegible]
N.Y., author of the best article in Volume XV[illegible] of Ind[illegible]
appeared in the May, 1960 issue, IQC.

Ellis R. Ott, left, of Rutgers • The State U[illegible]versity,
In the center is Paul S. Olmstead, sponsor [illegible]r the m[illegible]
the science of quality control.

The Department of Defense exhibits at the [illegible]Conventi[illegible]

Executive Session speaker, H. Thomas Ha[illegible]well, J[illegible]
ability and Waste."

For the Ladies' Program, Bonnie Small, Wes[illegible]rn Electr[illegible]
and Your Husband."

Mr. McClure presents a Special Resolution o[illegible] the Bea[illegible]
as editor of INDUSTRIAL QUALITY CONTROL.

A. V. Feigenbaum, president elect, ASQC, pr[illegible]ents a [illegible]
ASQC, to Mr. McClure.

...ent of section affairs, J. Y. McClure, president, ASQC, presents the Saddoris ...hairman, Los Angeles Section, ASQC.

...Republic Steel Corp., accepts the Edwards Medal and Citation from Mr. McClure. This was ... the Me... which honors George D. Edwards, distinguished pioneer in the development ...It is a...ded for outstanding leadership in advancing the practice and management of

...ugh Awa... to Richard A. Freund, Film Testing Division, Eastman Kodak Co., Rochester, ...olume IV of Industrial Quality Control. "A Reconsideration of the Variables Control Chart" ...QC.

... State University, New Brunswick, N.J., accepts the Shewhart Medal from Mr. McClure. ...sponsor for the medalist. The Medal is awarded for outstanding leadership in advancing

...s at the Convention included this Nike Zeus.

...omas Hal...well, Jr., president, Standard Pressed Steel, presents "Quality Control, Reli-

...all, Weste...n Electric Co., Allentown, Pa., presented an informal talk on "Quality Control

...solution of the Board of Directors to Mason E. Wescott upon the occasion of his retirement ...CONTROL.

...ASQC, pre...ents a Board of Directors Certificate of Appreciation for Service as President,

on the telephone, he agreed readily to loan it to me again. I had thought to bring it here, as an item of interest to you. Then second thought advised against it on this occasion—his many ideas, his organized approach in originating and outlining so many aspects of quality control—these should be the center of our honor to him.

It is a source of deepest pride to me to receive this award carrying his name. To the many colleagues who have accepted my questioning on statistical quality control to the point of pestering—to my university and industrial colleagues — I hope you will share with me a pride in this award.

In presenting the Edwards Medalist, Mr. McClure introduced his sponsor, George D. Edwards, who presented the Medalist as follows:

Fellow Members of ASQC, Guests and Friends of the Society:

It is my gratifying task, this evening, to support the propriety of conferring the Edwards Medal on Wade R. Weaver. *Seldom* have I had occasion to address you, on a more agreeable subject, or with greater pleasure.

Looking over his history in preparation for this job, I was first reminded that he and I went to the same "Prep School" — University School in Cleveland. We didn't meet there though, because my class preceded his by some eleven years. However, he was graduated *magna cum laude* in 1919—a considerably better record than I made, I can assure you.

Next, Wade made one of his few great mistakes—he went to Yale! But instead of letting that get him down, he capitalized on it. In fact he has immortalized himself:

When he received his degree in 1923, they sang:

"For God, for Country,
and for Yale."

He proceeded to change all of that, and for him, it has been:

"For God, for Country, for Yale,
and for ASQC."

From New Haven, Wade went directly to work for one of the original components of what is now Republic Steel Corp., and during the next twenty years, he ran the gamut of promotions in the "shop" organization — holding, successively, such positions as plant metallurgist, chief inspector, superintendent of the blooming mill, etc.

In 1944, he moved into the General Office as Chairman of the Surface Quality Committee, which position he *still* holds. In addition, he was somewhat later made Chairman of the Steel Conservation Committee; and *still* later Director of Quality Control.

In these three capacities, his responsibilities now cover all phases of process and product quality throug out the nine major steel-producing plants of Republic.

Now with that bit of *history*, perhaps I should return to my *main chore* of the evening.

In supporting the propriety of conferring this Medal on Wade, I first felt that I should take a fairly good look at just what the Medal is supposed to stand for.

For this purpose, I found *most* illuminating the Resolution of the ASQC Board of Directors creating the Award. This Resolution states that the Medal is (and I quote):

> ". . . for outstanding leadership in the American Society for Quality Control, and in the practical use of modern methods of quality control, especially by application procedures or by the organization and administration of quality control work."

So to support my thesis, I have to demonstrate to you: *first* that Wade Weaver has been an outstanding leader in ASQC; *and second* that he has displayed outstanding leadership in the practical use of modern methods of quality control.

Having broken down my job in this way, I submit that it is about as easy an assignment as I could hope to have. It seems almost redundant for me to recount to you Wade's almost countless contributions to ASQC from its very start.

As early as 1944, he was active in the organization of the Ohio Quality Control Society, and he served as its president from 1944 to 1946. He represented that Society at the organization meeting of ASQC in 1946—at which time the Ohio Society became the Ohio Section of ASQC. From 1946 to 1948, he served both as chairman of the Ohio Section and as Regional Director of ASQC—becoming a *Fellow* of the Society in 1947. He then served two consecutive terms as vice president, followed immediately by two consecutive terms as president of ASQC.

Particularly notable in his administration of the Society were his initiation of the Investment Program to aid the financial support of its activities, and his organization of the whole Convention Planning Operation which has proved so successful over the years.

During and following his Presidency, Wade served the Society with signal success for ten solid years, as chairman of its General Convention Committee. In the course of that time, he was perhaps more responsible than any other individual, for getting transferred to the Investment Fund, substantial Convention surpluses which had resulted so largely from his own labors on behalf of the Society. These surpluses have provided the back-bone of that Fund, and as chairman of the Financial Advisory Committee for the past ten years, Wade has so guided the administration of that Fund, that Society investments of slightly under $105,000. have a present worth in excess of $130,000.

I could go on with enumeration of Wade's many committee activities, but I'm sure I have already cited far more than enough to demonstrate his outstanding leadership in ASQC.

I have likewise cited sufficient of his performance and his recognition by Republic Steel, to demonstrate similar outstanding leadership on Wade's part, not only in applications of quality control procedures, but in the organization and administration of quality control work.

And so, Ladies and Gentlemen, I give you Wade R. Weaver as the Edwards Medalist of 1960. I'm sure you will agree with me that—as the Medal, and we in the Society do honor to him—so his acceptance of it will enhance the distinction of the Medal, and will do honor to the Society. Thank you.

The Brumbaugh Award winner, Richard Freund, was next introduced by President McClure. This year, for the first time since the change in the nature of the Award had been authorized by the Board of Directors, Mr. Freund was presented an appropriately engraved wall plaque to commemorate the Award. Mr. Freund received the award for his article, "A Reconsideration of the Variables Control Chart, with Special Reference to the Chemical Industries," which appeared in the May 1960 issue of *Industrial Quality Control*.

Everyone at the banquet was saddened by the announcement that Dr. Mason E. Wescott was relinquishing his post as Editor of *Industrial Quality Control*. In honor of the occasion, President McClure presented Dr. Wescott with an engrossed scroll of the Special Resolution of the Board of Directors. Dr. Wescott spoke to the group in such an inspiring manner that everyone must have felt that in this man was typified the humility that is possessed only by truly great men.

The guest speaker at the Banquet was Deputy Assistant Secretary of Defense, James N. Davis. Mr. Davis' excellent talk held the complete attention of the 900 persons present. His subject "Reliability—Where Do We Go from Here" covered trends in government activities that are intended to promote reliability. The talk was truly inspiring and will be published completely in the September issue of *IQC*.

Honors Convocation

At this year's Convention an innovation was made by providing a general session to permit suitable time for the addresses of the Shewhart and Edwards Medalists. Mr. Olmstead re-introduced Professor Ott at the Wednesday morning Honors Convocation with the following:

Last night, I traced for you the steps that led to the establishment of the Rutgers Statistics Center, the

first seminary for missionaries in the field of statistical quality control. It seems likely that the first Ph. D. from this effort will be given in 1962. The number of M. A.'s granted reached 100 in 1960. Present registrants include three from India, one from Thailand, and one from England. The staff includes five full-time professors, many joint professors, and over a dozen coadjutant instructors. Most of these instructors are people from industry who received their inspiration in the M. A. program.

While working to establish this dream, Ellis has had the support of several Honorary Professors, including Walter A. Shewhart, Harold F. Dodge, Enoch B. Ferrell, and Leslie E. Simon. There were, however, several other matters that helped to push his interest in the program, namely:

He became chairman of the Metropolitan section, 1950

He was a member of the Editorial Board, *IQC*, 1950-55

Under the Technical Assistance Administration of the United Nations, he was the coordinator of a quality control mission to India, 1952-53

He wrote a review of "Statistical Quality Control" for the American Society of Mechanical Engineers' "Ten Years' Progress in Management," 1953 (Previous reviews had been written by Walter A. Shewhart)

He became Editor of "Practical Aids" in *IQC*, 1954

He was chairman for the 1955 Annual Convention of ASQC

He wrote "Narrow Limit Gaging," *IQC*, 1954

He became Vice President of ASQC, 1956-60

Second Mission to India for United Nations, 1957-8

In 1957, he published the first of several papers on "A Graphical Analysis of Means" in the *Proceedings* of the Rutgers All-Day Conference.

In 1960, another United Nations Mission took him to Mexico City

In 1960, he was also invited to present a paper at the Fourth International Conference of the European Organization for Quality Control in London, England.

In addition, he has been a consultant at one time or another to several governmental groups and to various industrial concerns.

As a closing remark, I would like to quote from a tribute paid to him by one of his early M. A. graduates, William C. Frey:

"Any dissertation on Dr. Ellis R. Ott would fall far short of the mark if it did not mention somewhere that his dynamic personality and his intense enthusiasm for the Shewhart philosophy is an inspiration to all individuals who are in contact with him—in his classes, through his industrial consultations, and with his ASQC activities. He is truly, in every sense of the word, a disciple of the philosophy developed by the founder of our science. He lives this philosophy, he preaches this philosophy, and indeed he is successful in converting to this philosophy practically everyone who is associated with him."

The full text of Professor Ott's Shewhart Medalist Address appears on page 20 of this issue.

Mr. Weaver, the Edwards Medalist, was likewise re-introduced to the Convocation. The text of Mr. Weaver's address is presented on pages 24-25, this issue.

Exhibits

The Exhibits were an outstanding success for both the Society and the exhibitors. The exhibit hall of the Sheraton Hotel was modern in every respect and was an ideal atmosphere for the many exhibitors of quality control techniques and equipment. It could be seen that many worthwhile exchanges of information were taking place between the exhibitors and visitors. The following is a list of exhibitors:

American Cystoscope Makers, Inc.

American Society for Testing Materials

American Statistical Association

Boonshaft and Fuchs, Inc.

Brown and Sharpe Manufacturing Co.

Coca-Cola Bottling Company of Philadelphia

Convair—Division of General Dynamics Corp.

Coulter Industrial Sales Co.

Diversa Electronics

Elliott Service Co.

Encyclopedia Britannica

Engineers' Club of Philadelphia

Federal Products Corp.

Friden, Inc.

General Electric Company—Specialty Control Department

HOLCO Industrial Sales

- Cadillac Gage Co.
- Ex-Cell-O Corp.
- Gaertner Scientific Corp.
- Hamilton Watch Co.
- Optical Gaging Products, Inc.

Hunter Associates Laboratory, Inc.

Magnaflux Corp.

Martin Co.

- National Bureau of Standards
- George Washington University

Metal Powder Industries Federation

Monroe Calculating Machine Co.

Moore Products Co.

Nikon, Inc.

Pennsylvania Automatic Merchandising Co.

Professional Group for Reliability and Quality Control—Institute of Radio Engineers

Radio Corporation of America

Rototest Laboratories, Inc.

Society for Nondestructive Testing

Standard Gage Co.

Testing Machines, Inc.

Thwing-Albert Instrument Co.

United States Air Force

United States Army—Frankford Arsenal

United States Marines

United States Navy

Plant Tours

Many of those attending the convention took the opportunity of seeing quality control in action by attending one of the four plant tours. One hundred and three members journeyed to the Radio Corporation of America's Morristown location to see practical demonstrations in the electronics field. Approximately 50 members interested in metals and aircraft visited Standard Pressed Steel Co. Quality Control in the pharmaceutical industry attracted the attention of 100 members who signed up for the tour of Smith, Kline and French Laboratories. The Military Clothing and Textile Supply Agency welcomed 30 members on a tour of the finest textile laboratories in the world.

Reexamination

Now that the Convention and Exhibit has come and gone except for settling all accounts, a few words of appreciation are in order.

This year was the second joint effort between the National Office of ASQC and the local host committee. The General Convention Chairman, Julius Mehalek, and the members of his committees worked long hours for more than a year to produce a convention which appears to have been a success in all respects. Bill Youngclaus, our Convention Director, and his staff did an excellent job of overall coordination of convention activities. This same type of teamwork between the National Office and the Convention Committee should assure the success of future Annual Conventions.

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ASQC Announces

ADVANCEMENT TO THE GRADE OF SENIOR
(as of May 19, 1961)

Beyer, Edward, Sacramento, Cal.
Davis, Ray B., Denver, Colo.
Gifford, Richard L., Albuquerque, N.M.
Goetz, Victor J. II, Albuquerque, N.M.
Grumman, Eugene V., Fairfield, Conn.
Harrison, Thomas D., Albuquerque, N.M.
Johnson, Wilfred J., Adams, Mass.
Richards, Dale O., Ames, Iowa
Snodgrass, Laurence E., Albuquerque, N.M.
Steed, Robert C., Roselle, Ill.
Traver, Robert W. Sr., New Lebanon, N.Y.

ADVANCEMENT TO THE GRADE OF MEMBER
(as of May 19, 1961)

Burnahm, Peter W., Garden City, Mich.
Feurt, T. N., Tulsa, Okla.
Pharr, David L., Tulsa, Okla.
Pineau, Kenneth J., Pleasant Ridge, Mich.

ADMISSIONS TO THE GRADE OF MEMBER
(as of May 19, 1961)

Anderson, Frederick J., Lynn, Mass.
Bagley, Richard C., Detroit, Mich.
Barthe, Donald R., Pittsfield, Mass.
Bertolet, Nathan E., Scotia, N.Y.
Bianco, Guy R., Pittsford, N.Y.
Booth, Clarence E. Jr., Darien, Conn.
Bork, William J., South Plainfield, N.J.
Boyle, John T., Norwalk, Cal.
Broom, Perry M., Commerce, Texas
Brower, Preston S., Wrentham, Mass.
Brown, John, Downey, Cal.
Budryk, John R., Nabuassett, Mass.
Byczkiewicz, Victor J., Amityville, N.Y.
Carlan, John, Windsor, Ont., Canada
Cashman, James D., Great Neck, N.Y.
Castellano, Vincent J., North Andover, Mass.
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Chemness, Richard E., Smithtown, N.Y.
Christie, Stewart S., Grand Island, N.Y.
Clarkson, George W., Plainfield, N.J.
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Cohen, Milton I., Kew Gdns. Hills, N.Y.
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Cowdin, Paul E., Rancho Cordova, Cal.
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Dintino, Anthony, Toronto, Ohio
Dobalian, Vaughn, Peabody, Mass.
Dockery, Merritt E. Jr., Pittsfield, Mass.
Du Barry, Adrian P. Jr., Leceiba, Honduras
Edgerly, Herman D., Longmeadow, Mass.
Engelke, Walter C., Long Beach, Cal.
Estofinal, Earl J Jr., Conroe, Texas
Fiala, Frederick W., Havertown, Pa.
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Forsythe, James B., Roxbury, Mass.
Frazier, Hinton N., Minneapolis, Minn.
Frederick, Paul E., St. Louis, Mo.
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Hewitt, Harry J., Salt Lake City, Utah
Hite, Jack M., Ogden, Utah
Joffe, Boris B., Buffalo, N.Y.
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Kirschner, Stanley J., Sommerville, N.J.
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Kloock, Arnold G., Wayne, Mich.
La France, Everett L., Woburn, Mass.
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Lennox, Arthur S., Farmington, Mich.
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Levin, Howard R., Morton Grove, Ill.
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Ousley, Robert N., Long Beach, Cal.
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Ruf, Harold W., Milwaukee, Wis.
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Withrow, Robert V., Waltham, Mass.
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From the Scrap Box

IRVING W. BURR, *Editor*
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WHAT KIND OF PEOPLE?

ROBERT M. HOFSTEAD
Bristol Laboratories, Syracuse, N.Y.

The subject, *What Kind of People*, is one which should be dealt with frankly in order to have statistical quality control attain the professional rank it deserves and to maintain the rank once it is attained. The content of this article is of a highly controversial nature. The purpose is to stimulate self-evaluation for those entering the field of SQC and for those veterans with varying degrees of service.

Classification

People in this discussion are those SQC personnel in industrial plants. It is in the manufacturing industries where SQC does the most economic good and must continue to do so. Also, the majority of the membership in ASQC is industrial; therefore, what best applies to the manufacturing industries will act for the good of the entire ASQC membership. There are two broad classifications for industrial SQC people:

(a) Persons trained and skilled in another specific field such as Chemical Engineering, Mechanical Engineering, Tool Designing, and for that matter, Office and Management people, but who apply SQC techniques in their work.

(b) Persons who apply SQC techniques solely, although they may be trained and skilled in another specific field.

To reduce this distinction to a common denominator:

(a) Those who earn their take-home pay from a manufacturing concern for services rendered other than SQC

(b) Those who earn their take-home pay for services rendered in SQC.

The future of SQC will be determined by the second group. These persons have studied the principles of SQC and have accepted them as sound. However, they have gone beyond this. They have taken action. They have made the extremely important decision to accept SQC as their profession. Immediately these people can be classed as "hungry SQC workers." Their thinking and behavior differ greatly from those persons who are "friendly" to SQC.

ASQC LCS Codes 331:60;70:400

Recognition

SQC recognition has come about through the hard work of a relatively few individuals with initiative, foresight, and through military necessity. It should have surprised no one when the ever-present "opportunist" segment of a population climbed aboard a potential gravy train. However, the great majority of people connected with SQC are sincere individuals who work hard at the task of applying what they know about the science of SQC. As in any field of endeavor, people meet with different degrees of success.

What Kind Of People Will Be Most Successful In The Profession Of SQC?

All the attributes which are necessary for success in any other field are required. A few are intelligence, perseverance, common sense, a sense of humor, etc. However, beyond these requisites is one much more intangible. This is the ability to *think statistically*. Everyone, most likely, is born with *some* ability to *think statistically*. It can be compared to musical ability, mathematical ability, athletic ability, and mechanical ability. The hard truth is that just as everyone cannot be a successful musician, mathematician, athlete, or design engineer, neither can everyone be successful in the field of SQC. As with all the aforementioned capabilities, by sheer effort, one may develop beyond his innate capacity. Many have done this in SQC. In the end, the measure of the ability to *think statistically* is performance.

What Kind Of People Perform Best in SQC?

The people that have great confidence and the people that are highly competitive perform best in SQC. If a person does not firmly believe in SQC he should not enter the profession. There are many instances where persons have professed belief and have attempted to apply the methods. They have failed. An analysis of the situation showed they were merely paying "lip-service." Actually, if they had not run x number of routine operations during the working day, or copied y pages of recent information to be joined to past performance, a wave of insecurity would engulf them and they would feel unworthy of their pay check. This situation could arise because the person has not considered SQC as a professional service. An excerpt from a paper[1] has value along these lines:

> I think that all the signs show that statistical quality control or quality control taken as a profession, has decided to become a profession and to go through the front door of industry rather than through the back door. It appears to me that signs of the forthcoming profession in quality control are already with us. You know, in my field we believe that a profession has certain marks. If it does not have these marks it probably is not a profession—it is a trade. These marks of a profession that seem to apply to quality control today, seem to be these: First, it has a body of organized knowledge that is intellectually communicable. A trade is generally marked by the development of skill by doing the job over and over again. A profession is marked by the intellectual communicability of the subject matter. Statistical quality control seems to me to have the first mark of a profession.

Not only is confidence in the value of SQC necessary, but the person must have self-confidence. The SQC man must make decisions. He must make these decisions

based on probability in its complete meaning in a manner which will create a minimum of doubt in the minds of those concerned with the problem. Confidence instills confidence and this is necessary. After a phase of SQC is initiated in a department, confident decisions must be made by the operating personnel or there is delay, conference, dismay, and if a recall is not made, the quality control application may disappear. Rationalization on the part of the operating personnel will follow which can result in additional harm to the SQC man who initially had his foot in the front door.

A high degree of competitive spirit is necessary to perform successfully in SQC. Other professions such as Chemical Engineering, Mechanical Engineering, Chemistry, etc. are openly accepted professions. Their place in the pattern of industrial life is unquestioned. This is not entirely the case with SQC. SQC people who have closely associated daily in their respective "salt mine" with high calibre men in these professions will agree with this point of view. The management of the plant may back SQC 100 percent (by their definition), yet the patronal relationship will still be discernible. In many instances associates in other professions are quick to discover that there is something new in the SQC approach to their problem. In fact, very often they see an immediate use of a technique which will show them to be correct and Joe Doe of another department to be absolutely wrong. If such a convert were asked (soon enough thereafter) if the SQC man was worth his salary, he would unhesitatingly say "Of course!"—with fanfare. The experienced know such a breed are not constant backers to the thinking of SQC. The thinking is not of that nature. It has no favorite people. It deals objectively with facts and calculated figures. The SQC man must constantly compete, as a noncombatant, for better quality at lower cost.

An example[2] of the statistical approach to a problem showed the production department's process to be less variable than the analytical department's potency determinations. The statistician, having established the existence of this situation, will reap full reward from the exercise of all due caution in proposing corrective action. In all industrial plants there is departmental balance. There is a "live and let live" relationship regardless of what seems to be constant undeclared warfare. When this balance is disturbed by a third party, it certainly is a situation for only the confident and the competitive.

Conclusion

Not everyone is qualified innately to be successful in the profession of SQC. Personal attributes are required beyond mere training and experience just as is the case with other professional fields. Thought should be given to this situation in readiness for the future when formal education (e.g. QC Engineering) is available in our universities.

References

1. Paul J. Mundie, "The Human Factor in Quality Control," QC Conference Papers 1952, Sixth Annual Convention.
2. Robert M. Hofstead, "Reducing The Effect Of Process And Testing Variabilities," QC Conference Papers 1951, Fifth Annual Convention.

Call to Authors

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BOOK REVIEWS

Charles R. Hicks, Editor
Purdue University, Lafayette, Indiana

STATISTICAL THEORY AND METHODOLOGY IN SCIENCE AND ENGINEERING by K. S. Brownlee, Published by John Wiley & Sons., N. Y., pages v-570, $16.75. Reviewed by Dr. C. K. Tsao, Department of Mathematics, Wayne State University.

This text, as the author states in his preface, is "for students in the experimental sciences and partly for statistics majors, the main objective being to give both groups some facility and self-confidence in the actual use of statistical methods."

Chapter I introduces mathematical ideas, such as the concept of sample space, probability, distribution functions, mean, variance, covariance and correlation coefficient. Chapter II introduces statistical ideas such as principles of point and interval estimations and principles of hypothesis testing. The following chapters (Chapters 3-19) contain essentially (as usual) some detailed elaborations and specific examples of the first two chapters. The headings of these chapters are: Problems Involving the Use of the Binomial Distribution; The Hypergeometric and Poisson Distributions: The X^2 Distribution, the Multinomial Distribution, and Contingency Tables; Some Tests of the Hypothesis of Randomness: Control Charts: Some Nonparametric Tests; The Partitioning of Sums of Squares; Tests for Equality of Variances and Means; One-Way Analysis of Variance; Simple Linear Regression: The Bivariate Normal Distribution and the Correlation Coefficient; Two-Way Analysis of Variance; Three-Way and Four-Way Analysis of Variance; Partially Hierarchical Situations; Some Simple Experimental Designs; Regression in Several Independent Variables; The Multiple-Regression Approach to Analysis of Variance; Topics in the Design of Experiments.

The book is written with good care and is provided with many sets of problems (though not quite enough for average students). Analysis of variance is one of the major subject matters in this book. It can be recommended as a textbook for science and engineering students. (The instructor should elaborate some definitions and concepts, as is necessary in certain cases.)

WORK SAMPLING FOR MODERN MANAGEMENT by Bertrand L. Hansen, Prentice-Hall, Inc., Englewood Cliffs, N. J., 252 pages. Reviewed by Stephen J. Adams of Wolverine Tube, Division of Calumet & Hecla, Inc., Allen Park, Mich.

This book is devoted to the application of sampling for improving work efficiency. It is written at an easy-to-read pace and requires no prior training in statistical methodology.

The text is divided into three parts and interspersed with easy-to-use work sheets, alignment charts, tally sheets, random number tables and standard computation forms.

Part 1, consisting of 113 pages, is intended for those unfamiliar with the technique of work sampling. The author goes into detail in the preparation of a study in its entirety and illustrates the methodology with examples and applications in Quality Control, Inventory Valuation, Cost Control and Audit Verification.

Part 2, consisting of 63 pages, describes case histories contributed by various authors dealing with applications in maintenance, clerical activities, data collection, materials handling, research and direct labor. Also described is the use of photographic work sampling, a new cost control technique.

Part 3, Appendices, includes the theory and principles of work sampling. The section dealing with Random Time Sampling to Cost Estimates and Control is especially well covered from a statistical and mathematical standpoint.

The addition of *Work Sampling* to the required reading of administrative quality control personnel is highly recommended to supplement their backgrounds as supervisors.

STATISTICS: AN INTRODUCTION, A Wiley Publication in Mathematical Statistics, Fraser, D.A.S., John Wiley and Sons, New York; Chapman and Hall Ltd., London; 1958. ix + 398 pp. $6.75 Reviewed by B. V. Sukhatme, Statistics Department, Michigan State University.

This book is designed for a two semester course in mathematical statistics for students with one year of calculus. There are in all sixteen chapters, the first six giving in clear and straight-forward manner the material on probability theory, probability distributions and their characteristics which is now a fairly well established sequence to be found in many of the textbooks that are available. The book differs from the existing textbooks in that the author has given it a modern touch by including some material on more recent developments in statistical theory which is not to be found in any textbook written at this level.

Chapter 7 on sampling from finite population gives good introduction to analysis of variance while Chapter 8 is devoted to linear transformations

Carnegie Announces September-May Courses

During the coming academic year Carnegie Institute of Technology will offer, in its evening program, two-semester credit courses in Probability and Mathematical Statistics, Experimental Design, and Quality Control and Industrial Statistics.

The courses will meet one evening a week, Wednesday, Thursday, and Friday evenings respectively, 7:30-10:30 p.m., September, 1961 through May, 1962.

Registration for the courses will be Sept. 19, 20 from 6:30-9 p.m.

For further information regarding graduate and undergraduate day courses, write to Professor Edwin G. Olds, Department of Mathematics, Carnegie Institute of Technology, Pittsburgh 13, Pa.

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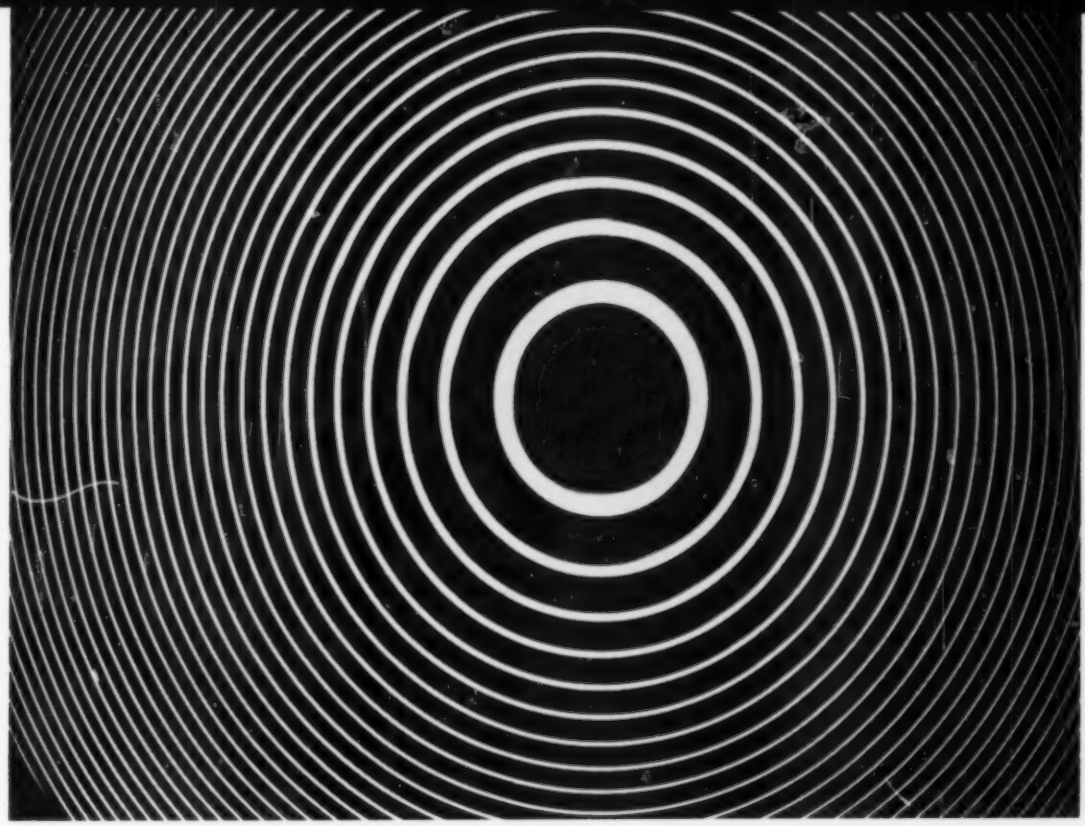


and solutions of linear equations. These topics are very rightly emphasized and also treated well.

Chapters 9 and 10 give introductory material on estimation and testing of hypothesis. The author has attempted to give a modern touch to the book by including Blackwell's theorem and has taken pains to emphasize the method of least squares.

Chapter 11 discusses the method of estimation by confidence interval. The discussion on fiducial inference could have been avoided without disrupting continuity of thought.

Chapters 12 and 13 on regression analysis and factorial designs are well written and likely to be most useful to students. The last two chapters dealing with sampling inspection, sequential analysis and nonparametric tests are too brief to serve any useful purpose.

On the whole, the book is well written though at times, new ideas such as conditional probability, independence of several events, etc., are introduced in a rather unsatisfactory manner. The notation is standard and clear.

The book gives a large number of exercises at the end of each chapter which will be of great help to students in understanding the theory.

Except for the minor drawbacks pointed above, this book is a good addition and is likely to be appreciated by students for whom it is designed.

George Washington University Course Includes Measuring the Infinitesimal

Interference fringes, formed by the green-colored radiation of an isotope of the liquid metal mercury, appear as dark fuzzy shading along the edges of the white concentric rings.

The particular isotope (atomic mass 198) is stable and is created in this case by the transmutation of gold, the reverse of the medieval dream of the alchemists. The gold is bombarded in an atomic pile by heavy subatomic particles without electrical charge, called neutrons.

The minute fringes that result from the interference of light-waves radiated from the mercury isotope are uniformly stable and are used as a standard of length accurate to one part in a hundred million.

The system of using these fringes as a basis for such precise linear measurements was developed by Dr. William F. Meggers, U.S. National Bureau of Standards. Although the reddish orange light from another isotope, Krypton-86, is now used as an international standard of length, the mercury-isotope, in glowing lamps, is used throughout the world as a *working* standard.

Industry representatives will be brought up to date on such developments in the science of metrology (measurement) during a summer course offered by the George Washington University Center for Measurement Science, Washington, D.C., Aug. 14-25. The course will program a full schedule of classes from 8:30 a.m. to 4:15 p.m. daily. Subjects to be covered include "Design of Experiments" and "Time and Frequency Measurements."

Instructors for the classes will be drawn from the George Washington University faculty, the National Bureau of Standards, Johns Hopkins Applied Physics Laboratory and the Weinschel Engineering Company. Laboratory sessions will be under the auspices of the Bureau's educational committee.

The Center, established last fall with the support of the National Bureau of Standards and The Martin Company of Baltimore, Md., was formed to meet a vital gap in America's scientific educational program in metrology. The first classes were held in February at the University campus.

Admission to the program will be limited to persons currently employed in the field or possessed of at least a bachelor's degree with a good working knowledge of algebra and trigonometry.

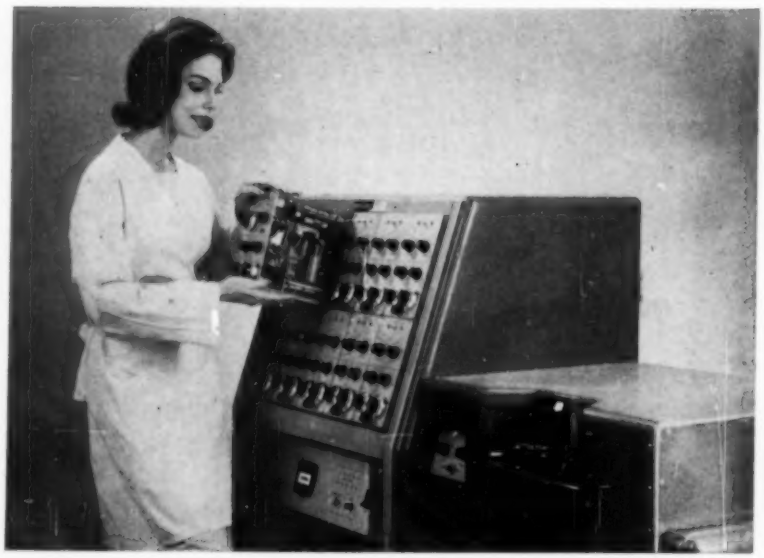
What's New?

ROY A. WYLIE, *Editor*

801—A new series of Random Noise Sources which provide random "white" noise with Gaussian amplitude distribution has been announced by H. H. Scott Inc. The units utilize an octal socket for both standard console power input and random noise output. Random noise is used for approximating electrical signals and disturbances, sounds, and vibrations for both general investigations and environmental testing. The new 812, 813 and 814 random noise sources are an economical choice for those applications in systems and laboratories where the sophistication of instruments like the H. H. Scott 811B Random Noise Generator is not required. The 812 series provides random "white" noise with true Gaussian amplitude distribution where a limited degree of flexibility is required. By use of two 3 position frequency cutoff switches, nine selected frequency ranges of noise are available. The 812-1 is designed primarily for vibration work, while the 812-2 is useful for general audio frequency investigations. Special models of the 812 incorporating any three selected lower and upper cutoff frequency from 3c to 50 KC are available. The 813 series of Noise Sources provides output in any single fixed frequency range desired (within 3c to 50 KC) with a cutoff rate of 6 or 12 db per octave. Output will vary from 1v RMS to 3v RMS depending on the frequency range selected. The 814 series of Noise Sources are engineered and produced to order. They provide a noise output with shaped spectrum for simulation of specific noise environments. The 814 will find application in telephone line testing, telemetering, probability generation, acoustic analgesia, production component testing, creating speech interference and masking signals, and simulating ambient sea noise.

* * *

806—One of the problems in inspection and assembly of small parts is the transfer of the salts, acids and moisture of perspiration to polished machine surfaces. A barrier cream, "Kerodex" 71 is now being used to prevent this. The cream, which is water-repellent, is applied to the hands and effectively prevents the transfer of perspiration moisture to handled parts. Acting like an invisible glove, the cream is greaseless, stainless and will not affect materials or surfaces. "Kerodex" 71 has a wide use in industry generally to protect against all liquid irritants, as acids, alkalis, etc. Used in inspection and assembly routines, it guards expensive pieces against hand moisture.



811—A new system for high speed testing of electronic components has been introduced by General Precision's Librascope Division. The system, called SATE for Semi-Automatic Test Equipment, is designed to replace the tedious manual testing now necessary to provide component reliability. SATE will evaluate components for combinations of ten parameters and accept or reject each at a machine rate of 1800 components per hour. SATE is priced at between $16,000 and $20,000 depending on the number of plug-in modules specified by the customer. Each module in the electronic console controls one of ten test stations in the mechanical handling console. The modules contain binary-type logic circuitry for making go/no-go decisions. Each module is provided with controls for setting test conditions and establishing parameter limits. An operator inserts components in a revolving table in the mechanical handling console. The table carries the component to each of the ten test stations. At each station the component is tested for a different parameter and is automatically rejected if it fails to meet predetermined limits. Design of the mechanical handling console provides for the testing of devices with ten terminals or less. Plug-in modular circuitry incorporated in the design of SATE permits flexibility in application for immediate uses and adaptation to changes in the state-of-the-art in the electronic component industry. SATE automatically performs a continuing self-checking function during operation to insure testing accuracy.

807—In effect a 360-sided optical polygon, a new Milichex Model MOX-3600, provides users with a multi-purpose tool for optically checking alignment and angular spacing in any multiple of full degrees. The Model MOX-3600 is a compact, high-precision indexing device with an optical mirror mounted on its rim. It is accurate to within 0.000012 inch at 20-inch diameter. When used with an autocollimator or similar optical sighting device, the optical polygon provides an accurate mirror surface which reflects the projected image of the sighting device's cross hairs. The amount of deviation between the reflected image and the graduated cross hairs in the sighting device gives a geometric check on misalignment, parallelism, angularity, etc. Featuring versatility of use, the Milichex Model MOX-3600 optical polygon is ideal for shops having a large variety of optical checking needs. It replaces any conventional multisided polygon divisible into 360 degrees. The Model MOX-3600 can be used in inspection, manufacturing or in the field.

* * *

808—The Rauland Corporation has announced a new gamma ray image intensifier system that detects minute flaws in four inch thick steel and other dense objects and projects images of the flaws on a TV screen. Used in conjunction with the Picker Orthicon Camera and "Cyclops" Cobalt 60 unit, the new Rauland intensifier tube will permit an assembly line-type of continuous inspection of dense materials, which heretofore could be inspected only by

gamma ray photographs, and of other materials which could not be inspected without destroying them. Gamma rays produced by a dime-sized piece of Cobalt 60 can penetrate dense materials better than room-sized X-ray machines. Their energy is so great that before the Rauland tube was developed, they could not produce a satisfactory image on a conventional fluoroscope. In operation, gamma rays from the Cobalt 60 are directed through the material being inspected to a thin metal plate at one end of the new Rauland tube. Here some of their energy is transferred to electrons of low enough intensity to produce a fluoroscopic image, which is intensified by the tube to produce a picture at the other end about 1000 times brighter, sufficient to provide a clear picture on a remote TV screen or to be viewed directly through an optical system.

* * *

802—Freezing Point Standards, furnished with National Bureau of Standards certified freezing point samples, are being introduced by Temptron, Inc. The apparatus provides an accurate and convenient means of reproducing primary and secondary points in the International temperature Scale for the calibration of temperature sensing devices. Temptron's Freezing Point Standards are designed to utilize the methods specified in Section 3.1 of NBS Bulletin 590, "Methods of Testing Thermocouples and Thermocouple Materials." The Freezing Point Standards are shipped complete and ready for use with the certified metal samples contained in ultra-pure graphite crucibles and hermetically sealed to prevent contamination. Additional features include automatic temperature control, rapid warm-up, long freeze-out time (15-20 minutes), and simplicity of operation.

* * *

803—The Webber Gage Company announces the development and production of two new series of their Croblox (solid chrome carbide) Gage Blocks. One series known as "Thin" blocks has been planned to meet the specific needs of the many manufacturers who produce miniature precision parts. The 28 Croblox "Thin" set includes blocks ranging from 0.010 inch to 0.090 inch in A+, AA, and Laboratory Master accuracies. Another Croblox series includes two sets, one of 11 and another of 21, and is available in five millionths and ten millionths steps, in Laboratory Master grade. All blocks are rectangular style. Individual Croblox blocks are available from these sets in sizes ranging from 0.100 inch to 0.100005 inch, and 0.1000010 inch, etc. through 0.1001 inch in Laboratory Master grade. A feature of the 21 and 11 block sets is that the linearity of the scale on electronic comparators or other instruments can be checked in five millionths or ten millionths steps to an accuracy of less than one millionth of an inch.

* * *

810—The firm of Dr. Lehfeldt & Co., Heppenheim, West Germany, announces the development of new equipment for the ultrasonic testing of wire. The Lehfeldt equipment permits the detection of inclusions, as well as cracks running in any direction, in one operation. Flaws and other discontinuities as small as ten percent of diameter of fine wire can be detected with great accuracy. The design of the Lehfeldt equipment has overcome the problems of sound coupling between transducer and wire by using a liquid meniscus formed over an opening. Since there is no longer a mechanical coupling involved, wire can be tested at drawing speeds of up to 200 feet per minute and more. The entire operation can be automatized by the use of additional equipment, also available.

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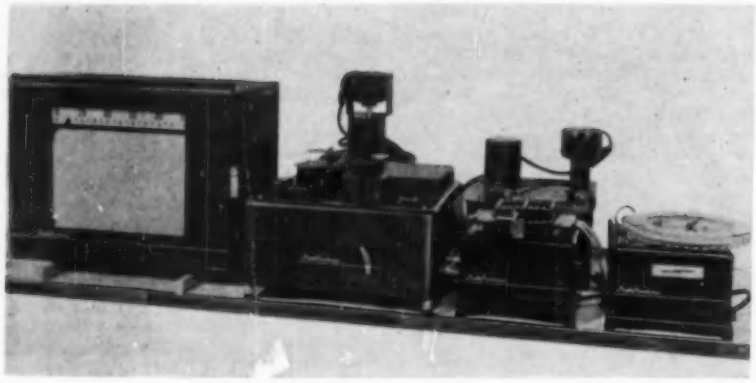

804—A new differential AutoAnalyzer for continuous chemical analysis, with automatic blank or interference compensation, that can detect trace materials down to parts per billion with an accuracy of one percent is announced by Technicon Controls, Inc. Providing dependable analysis with exact reproducibility, the Technicon AutoAnalyzer automates all steps of a chemical analysis now performed manually and integrates them into a continuous flow system. The instrument system automatically measures, mixes, purifies, processes, compares and records, and runs 20, 40 or 60 complete tests without human supervision. A differential colorimeter automatically cancels out high blanks or colored samples which interfere with an analytical reading. A two-position switch permits use as either a differential colorimeter or two separate colorimeters. By feeding an untreated sample (reference) to one flow cell, and the sample to be analyzed to another, the dual colorimeter provides a reading which is the true value equivalent of the treated minus the untreated sample. Operated as two individual dual-beam colorimeters in the same housing, the unit permits each channel to operate independently of the other. Each measures the output ratio of sample vs. reference recorded in terms of optical density. Selenium photo-cells are used for 400-650 mu. wavelength range. Hermetically sealed pairs, they are matched for sensitivity, spectral response, and temperature coefficient. For wavelengths between 600-950 mu., silicon photo-cells are employed. AutoAnalyzers are available for single or multiple component determinations, for laboratory or plant use. Among the host of materials analyzed by the Technicon system are cyanides, silica, phosphates, iron, chloride, sugars, aluminum, sulfates, copper, etc.

* * *

812—Production of Model 150-HLA-T, a versatile, new precision vibration fatigue testing machine designed for pilot, spot or production line testing of electronic, electrical, optical and mechanical equipment, is announced by All American Tool Mfg. Co. Built to conduct gruelling vibration tests calling for a broad range of frequencies, the Model 150-HLA-T exposes hidden defects by subjecting equipment weighing up to 150 lbs to extremes of horizontal vibration far more severe than actual service conditions normally impose. Model 150-HLA-T has an overload safety factor of 50 percent and operates on selected cycles or through the full frequency band of five to 100 c.p.s. Acceleration and deceleration are electronically controlled. The new unit, like other All American testing machines, meets government specifications. Its 18 x 21 inch table area, 26 x 48 inch base and 13½ inch overall height adapt it very well to limited space areas.

809—The Federal Micro-Sure Dial Indicator represents a new concept in indicator mechanism design. By eliminating the conventional rack and pinion and incorporating a new type of motion transfer arrangement, the Micro-Sure Indicator is able to provide high magnification (0.000050 inch grads.) over the full AGD range with two to four times the calibration and repeat accuracy of conventional indicators. The new design also prevents stem bushing wear from having any effect on accuracy of the indicator and permits cleaning to be performed in one tenth the time normally required. Because the mechanism follows the plunger motion, instead of being driven by it, the indicator has positive protection against shock in either direction. Micro-Finish of critical surfaces reduces friction to ¼ that of conventional indicators. The high degree of precision made possible over the full AGD range, plus the protection against shock and wear, permits the Micro-Sure Indicator to be used for production gaging in applications which normally call for more elaborate measuring devices.

805—The new ADCO transistorized cable tester makes cable testing as simple as testing a tube, and provides digital readout. The Model 50 quickly, accurately, and automatically examines each wire individually for faults. Leakage and short circuits between conductors resulting from defective insulators, improperly connected wires, cold solder joints or damaged wires are located. Deviations or resistance to 0.1 ohm for continuity and leakage up to 100 megohms are detected. The accepted or rejected wire is identified through a clear digital readout. Sequencing on this rugged instrument is either manual or automatic, adjustable to a maximum of one circuit per second. The Model 50 handles 50 or more conductors with provision for unlimited combinations of wiring, cable connectors or terminal lugs.

New Literature

831—Accurate, simple and quick measurement of the largest hole in a filter element can be made with the Bubble Point Test Stand described in Bulletin A-11 available from the manufacturer. The test stand is used to detect damage or otherwise imperfect filter elements prior to installation in an aircraft, missile or ground system.

* * *

832—The 1961 Hewlett-Packard catalog of electronic test instruments is

now available. This 220-page catalog contains complete listings, descriptions and specifications of the more than 400 test instruments offered by Hewlett-Packard Company. It also includes a 16-page descriptive listing of the special systems and instrumentation produced by the company's Dymec Division.

* * *

833—A 12-page brochure on the Schlumberger NMR (nuclear magnetic resonance) Analyzer and its applications is now available. The brochure is illustrated with diagrams and charts, discusses the basic principles of nuclear magnetic resonance analysis, and covers a variety of product quality control, process control, and research uses for Wide Line NMR analytical techniques in chemical, textile, food, tobacco, paper, plastics and many other industries.

* * *

834—Two new two-page specification sheets describe features and technical characteristics of nuclear density measuring gauges for processing applications employing pipe three inches in diameter or smaller. Main differences in two gauges are methods of creating null measurement; one uses electrical zero suppression and the other a compensating cell. Methods determine measurement ranges in specific gravity units. Literature describes operating principles and installation method in processing line without enlarged pipe sections.

* * *

835—A 12-page bulletin, RF-2-61, describes Riehle-Los Hydraulically Actuated Fatigue Testing Machines. Capable of testing material specimens and complete structural components, these machines can also be used for conventional static testing. An optional programmer automatically varies load control points and frequency. The new bulletin, illustrated with full color photos and hydraulic flow control charts, contains complete specification tables and descriptions of general purpose testing cylinders and accessory controls.

* * *

836—The GKI Model Seven Tape Tester is described in a brochure now available. The Model Seven is designed specifically for testing magnetic tape and is to be used for preventive maintenance of magnetic tape in computer installations or for production testing new tape.

* * *

837—The Sheffield-Ferranti FI-22 Coordinate Measuring Machine is described in a new four page brochure. The machine measures the distance between holes and surfaces in two dimensions (X and Y) to an accuracy of better than 0.001 and flashes the answers out on two illuminated digital readout panels much like an automobile odometer indicates the distance a car has traveled. One of the features of the machine is the use of Floating Zeros that enable the inspection operation to begin anywhere within the 15 x 24 inch gaging range.

* * *

838—A new brochure describes the complete line of equipment made by Steel City Testing Machines, Inc. Brinell hardness testing machines, Penetrascopes, ductility testers, tensile and compression testing machines, transverse testers, hydrostatic and pneumatic testing machines, proving rings and calibration presses, and special testing machines are discussed.

* * *

839—Publication of a 1961 catalog of American Standards which now number 1973 has been announced by the American Standards Association. The booklet, which is available without charge from the ASA, contains a listing of special publications in the standardization field, pamphlets and standards recommendations of the International Organization for Standardization and the International Electrotechnical Commission. It also has an index to titles of American Standards and international recommendations. The listing of American Standards is broken down into the various phases of application, and these include civil engineering and construction, mechanical engineering, electrical engineering, automotive, ferrous materials and metallurgy, nonferrous materials and metallurgy, rubber, chemical industry, textile industry, mining, materials handling, nuclear, wood industry, pulp and paper industry, photography and motion pictures, acoustics, vibration, mechanical shock and sound recording, office equipment and supplies, drawings, symbols and abbreviations, and miscellaneous and commercial standards.

* * *

840—The American Society for Testing Materials has announced that the 1960 supplements to the 1958 book of ASTM Standards has been completed. Each part-supplement brings up-to-date the corresponding part of the 1958 Book of Standards and the 1959 supplement by including new standards and revisions adopted in 1960. The book of ASTM Standards is published triennially with supplements in intervening years. The book and supplements contain over 2700 standard specifications, methods of test, recommended practices and definitions of terms for materials.

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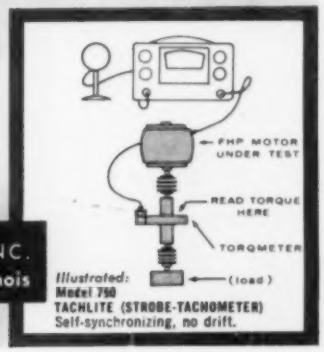
Model 784 POUND-TORQMETER
measures up to 200 lb. —inch
Model 781 GRAM-TORQMETER
measures from .05 gm-cm to 5 gm-cm



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NOTE: A few choice territories available for experienced representation.

841—A new four-page Data Sheet EB2 (1) describing precise d-c electrical resistance standards is now available from Leeds & Northrup Co. The electrical standards described include: the Thomas-Tye One-ohm Standard with a measured value given to one part per million; N.B.S. Type Resistance Standards; Reichsanstalt-Type Resistance Standards; secondary standard d-c resistors; a mercury-cup stand; shunts for large currents and secondary-standard a-c resistors. The specifications of the complete line of standards is given, and significant design and manufacturing techniques are described. Electrical characteristics are tabulated and construction features included.

* * *

842—A brochure describing the Model 202 Spectrophotometer, a new low-cost instrument operating in the ultraviolet and visible region of the electro-magnetic spectrum, has been published by the Instrument Division, Perkin-Elmer Corp. The instrument covers the 190 to 390 millimicron region in the ultraviolet and the 350 to 750 millimicron region in the visible. The Model 202, which operates on the optical null principle, features an automatic gain control system, a 60° prism for high dispersion, and an accurate photometric performance. Applications in the ultraviolet region include the analysis of organics, particularly aromatic or heterocyclic compounds or other compounds with conjugated bonds, as well as a wide range of applications in the visible region.

* * *

843—A new brochure on suggested standards for black light quality control equipment has just been issued by Ultra-Violet Products, Inc. Recommended standards in the booklet were formulated with the cooperation of the U. S. Army Corps of Engineers and the U.S. Air Force. Brochure is designed to aid in quality control of printed circuitry, flaw detection, leak testing, liquid oxygen service equipment and other fields where black light is being used as a control.

* * *

844—Technical Data Sheet #1124-61 completely describes the Sine-Line Model 1124 Involute Checker, which includes optical setting of the sine bar so accuracy of the instrument is independent of operator "feel." Angles can be set within 0.001 inch without use of gage blocks. This data sheet describes the operations of the involute checker and shows how it is applied to rapidly check consistency of form of successive teeth. The optical system has been designed as an attachment so it can be used with Models 1124 and 1124-C already in use.

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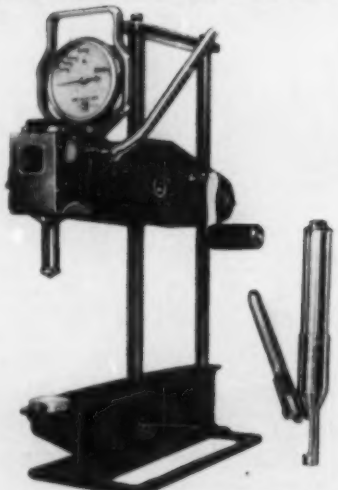

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Inquiries for the following new literature may not be addressed to Products Education Service. Requests for literature and payments, when required, should be sent to the companies listed below.

* * *

Screw-Thread Standards for Federal Services, 1957, National Bureau of Standards Handbook H28 (1957) Part I, amends in part H28 (1944) (and in part its 1950 Supplement), issued September 10, 1957. This publication represents the work of the Interdepartmental Screw Thread Committee, which is sponsored by the Departments of Defense, Navy, Air Force and Commerce to promote uniformity in screw-thread standards in the Departments concerned. The handbook is based on the 1933 and earlier reports of the National Screw Thread Commission and NBS Handbooks H-25 (1939) and H28 (1942 and 1944), together with pertinent standards approved and promulgated by the American Standards Association. Order from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. Price is $1.25.

* * *

A new abstract service, *Operations Research/Management Science*, recently has been announced by Interscience Publishers, N. Y. This monthly service is designed to provide management decision-makers with a running account, and a permanent reference source, of all significant contributions to this fast-growing field. *OR/MS* is an outgrowth of *Quality Control and Applied Statistics*, an Interscience digest service begun some six years ago. However, the increasing amount of material pertinent to operations research and management science, and the distinct place these functions have found in the present-day industrial and military tables of organization, has justified a new and separate service. The editors of *OR/MS*, who are also the editors of the Quality Control Service, are Robert S. Titchen, operations analyst with the Operations Evaluation Group, MIT, in Washington, D.C., and Arnold J. Rosenthal, research associate with the Celanese Corporation of America, Summit, N.J. *OR/MS* coverage is international; its editors and reviewers select from about 400 journals and technical meeting transactions published throughout the world. Papers are abstracted by *OR/MS* reviewers, many of whom are themselves contributors to this field. Subscription price is $75 a year. Orders may be directed to Interscience Publishers, Inc., 250 Fifth Avenue, N.Y. 1, N.Y. A special combination price is available to subscribers to the companion abstract service, *Quality Control and Applied Statistics*.

Some of the newly elected officers and committee chairmen of the Sacramento section are shown with their guest speaker, John Harrington, vice president, Metrolonics, Inc., Burbank, Calif. Standing, from the left, L. W. "Doc" Lepkowski, education chairman; Frank Shilosky, program chairman; Mr. Harrington; Lloyd Rowe, Saddoris Award chairman; Tom Jasper, historian; Maury Walker, publicity chairman; Bill Smith, membership chairman, and Harold Lemley, arrangements chairman. Seated, Mrs. J. Ashton, secretary; Paul Reis, chairman; Ray Steuer, vice chairman, and George Wagner, treasurer. All section members pictured are with Aerojet-General Corporation except Mrs. Ashton of McClellan AFB, Calif.

section briefs

AKRON-CANTON . . . May 19, Ladies' Night, Firestone Country Club . . . Social hour, steak dinner, and after-dinner ceremonies enjoyed by 40 couples . . .

Past section chairmen Donald Dewing, Robert Dorn, and Lawrence Bedford were presented appropriately inscribed desk sets as a token of appreciation for their leadership which has progressively advanced our section's national standing to within striking distance of the top.

The principal speaker for the evening, E. H. Hartley, manager of Shopping Services, Halle Bros., presented a very humorous though realistic talk entitled "The Customer is Always Right."

David Gorsline, U. S. Stoneware, Ravenna, Ohio, will be the new Section Briefs correspondent for the 1961-62 season.

H. P. Pierce

ALLENTOWN-BETHLEHEM . . . Our section conducted two meetings this month. The first of these, the regular monthly meeting, was held at the Hotel Traylor, Allentown, Pa., on May 10. "Nuts, Bolts, Tolerances and a Bit of Operations Research" was presented by Dr. Frank E. Grubbs, chief, Weapon System Laboratory, Aberdeen Proving Ground, Md.

Our second meeting was held in the IBM sales offices in Bethlehem, Pa. It was conducted by Marsh Warner, applied science representative, IBM Corp. Mr. Warner showed us examples of Automation in Quality Reporting which he had developed and used in the course of routine inspections. He demonstrated means of analyzing attribute and variables data on the IBM 1620 Data Processing System, which was installed for demonstration purposes at Bethlehem.

David F. Roberts

BALTIMORE . . . At our annual Management Dinner Meeting, Wyatt Lewis, Quality Control Engineering Service, General Electric Co., New York City, ably substituted for William J. Masser, also of General Electric Co. In speaking on Total Quality Control, he explained that this concept permeates the present day thinking of quality control application in industry—currently being confronted with a new era of competition. Mr. Lewis outlined the building blocks of such a total quality control program encompassing Quality Control Engineering, Process Control Engineering, and Quality Information Equipment Engineering. He gave an example in which one company was able to effect appreciable savings by this multi-functional effort to improve quality and reliability of product.

At this meeting our new officers and executive committeemen were announced. Our outgoing chairman Russel G. Hutter, Air Arm Division, Westinghouse Corp., commended those who helped to make this past year a successful one. Ralph Taylor, Catalyst Research Corp., will be our new chairman, and indications are that he is already making plans to get the ball rolling for the 1961-62 year.

A. M. Reek

BATTLE CREEK-KALAMAZOO . . . Our thanks go to the following persons for their magnificent work on our First Annual Forum May 13, 1961: Dr. Andrew C. Luff, general chairman, Forum committee, and Guy Benson, Clarence Oranje, Charles Beazley, Deland Davis, George Church, Roy Groulx, E. E. Stephenson, Carl Huprich, and others behind the scenes who have made this Forum a success. Plans are now in the making for

next year's Forum. Dr. Andrew C. Luff has again been asked to be general chairman.

May 18, Ladies' Night was also recognition night for the retiring officers for the past year . . .

The following are the new officers for 1961-62: chairman—Eugene R. Conolly, Rich Manufacturing Co.; vice chairman—Ralph E. Anderson, Engineering Castings, Inc.; secretary—Dr. Aubrey F. Wylie, Michigan State University, and treasurer—Donald E. Byro, Michigan Carton Co.

Committee chairmen were chosen as follows: program—Charles C. Beazley, General Foods Corp.; Saddoris Award, Clarence J. Oranje, KVP-Sutherland Co.; membership—James J. Monk, Eaton Manufacturing Co.; auditing—Deland H. Davis, Post Cereals, and *IQC* correspondent—Peter F. Koets, Allen Electric and Equipment Co.

Peter F. Koets

CHICAGO . . . Hi! It appears I jumped the gun by mentioning last month that I would have the 1961-62 election results in this issue. Balloting was a little late, but the outcome will be in the September issue.

The basic statistical quality control course and inspection training program both will begin in September. I'll try to have some details on that and the first general meeting in next month's issue.

John Dittrich

COLUMBUS . . . May 17, R. D. Draudt, chief quality control analyst, North American Aviation, Inc., Columbus Division, presented a very interesting program on reliability evaluation of a weapon system. . . .

Mr. Draudt described the elapsed time meter system, which was used to measure and/or evaluate achieved electronic system reliability during the A3J weapon system development. The meeting was held at Westinghouse Corp.

George E. Arris

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No reference standards are required with the Sheffield-Ferranti machine for measuring and laying out location of holes and surfaces to X & Y coordinates. Part tolerances of .001 and larger are indicated to the nearest .0005 with direct visual readout in lighted ¾" numbers. Instant zero reset—working range 15" x 24". Save time by rushing request for Bulletin FI-22.

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Leo J. Nartker (left) superintendent reliability coordination, Delco, describes quality control documents during a tour of Delco products conducted for J. Y. McClure (center) president, ASQC, before he told the Dayton section about latest developments within the Society. Looking on are Ken Holliday, quality control engineer and section program chairman, and R. C. Stockert, supervisor of quality control and reliability engineering and section chairman, 1960-61.

DAYTON . . . May 4, the meeting was preceded by a dinner at the Van Cleve Hotel . . . J. Y. McClure, president, ASQC, spoke on the recent developments within the Society . . .

Prior to the meeting, Mr. McClure toured the Delco Product Division, General Motors Corp., and facilities of National Cash Register, where he reviewed the quality control procedures in use at each installation.

Harleigh F. Diehl

GREATER DETROIT . . . June 24, the section held a dinner-dance at the Statler-Hilton . . . Just an evening of fun—with dancing and singing . . . No speeches this time . . .

Frances D. Huntington

HAMILTON-MIDDLETOWN . . . Due to industrial layoffs within the area, attendance at an intermediate level statistical quality control course was affected and 12 persons completed the course in May . . .

May 26, executive committee meeting covered program and financial planning . . .

Aug. 3, education committee will meet to complete plans for the coming season . . . Plans include a college extension graduate and undergraduate course in quality control and industrial statistics, quality engineering seminars, and quality control presentations before local junior and senior high schools . . .

Lon Ely

HARRISBURG . . . May 3, Ladies' Night, tour of the Hershey Chocolate Corp., Hershey, Pa. . . . Section members conducted their wives and friends through the home of the famous Hershey bars . . . We saw the cacao beans being washed, roasted and ground, rolled and processed into cocoa, cocoa butter, oil of cocoa, baking chocolate, and refined into milk chocolate . . .

Dinner followed at the Cocoa Inn, Hershey, Pa. Guest speaker was Arthur S. Graham, chemist for candy manufacture. He described the difference between cacao beans, cocoa, milk chocolate—sweetened and unsweetened, and oil of cocoa.

The history of chocolate manufacturing and processing was traced from Aztec Indians in Central America to the United States in 1800 and later to Switzerland in 1876, where milk chocolate was first perfected.

Ann Englehart

HARTFORD . . . May 9, the Bob Selig Award—a memorial given annually to the member making the greatest contribution to the Hartford section—was presented to Eugene Ellis . . . Conrad Chilone was given the Education Award for his excellent chairmanship of the Education Committee . . .

Mr Ellis, section chairman, has appointed the following committee chairmen for the 1961-62 season: Saddoris Award—R. Fowler, Pratt & Whitney Machine; *IQC* correspondent and publicity—E. May of Royal McBee; one day seminar—S. Burg of Stanley Electric Tool; program—A. Kasmierski Stanley Works; membership—M. Kesten, Dynamic Controls; education—R. Phelps, Royal McBee; By-Laws—L. Greenbaum, Allen; and arrangements—J. Hunt, Cramer Controls.

L. Sespaniak

STATE UNIVERSITY OF IOWA . . . May 27, members enjoyed a "strictly social" evening which included a social hour, dinner, entertainment and dancing . . . The evening, held at the American Legion, Moline, Ill., was planned by our retiring program chairman, Bob Cannon, of Eagle Signal . . .

E. B. Godsey

KANSAS CITY . . . May 18, acknowledgment of the accomplishments and services of former section chairman G. Michael Putthoff took the form of a presentation of a desk set to him at the Kansas City section meeting . . . Former section chairman Jay Rumberger, who made the presentation, emphasized that Mike's value to the section was even greater than would appear on the surface because he continually prodded and inspired others to be more productive.

In his acceptance, Mike set forth still another worthwhile objective for the section, suggesting the establishment of a scholarship fund for deserving students who are interested in quality control as a part of their career objective.

H. Afton Taylor

LIMA . . . May 9, meeting at Cleman's Bldg., with installation of officers . . .

Oct. 6-7, intensive course in reliability sponsored by the Lima section, ASQC . . . Harmon S. Bayer, Quality Control Consultant, Detroit, Mich., will be the instructor . . . Contact D. C. Fultz, Lima Engine Plant, Ford Motor Co., Lima, Ohio . . .

C. J. Dukro

LOS ANGELES . . . May 23, IAS Bldg., meeting held by the Garrett Corporation with C. N. Monson, vice president, as spotlight speaker . . . His topic—"Small Business Sub-contracting in a Multiple Product Plant" . . . AiResearch provided a very interesting panel on Multi-Plant Product Problems . . . 332 ASQC members and guests attended one of the most interesting meetings of the year . . .

S. Kozich

MEMPHIS . . . May 15, Richard A. Freund, Film Testing Division, Eastman Kodak Co., Rochester, N. Y., told how a blend of the Shewhart Control Chart and Acceptance Sampling Technique would be appropriate for many of the problems in the chemical industries . . . His topic "Variables Control Chart" . . .

Lee Dickerson

MID-HUDSON . . . May 2, 45 members and guests heard Dr. J. M. Juran seak on topics from his *Handbook of Quality Control* . . .

His main topic outlined a chapter from his revised book, entitled "Quality Mindedness." The theme concerns two attitudes of quality mindedness, "The craftsman attitude and the indifference attitude."

Dr. Juran stated that the craftsman attitude is the inherent desire to accomplish a quality job, and the indifference attitude that of production people to produce good quality only under pressure.

Walter W. Wagner, section chairman, 1961-62 season, is completing his selection of committee chairmen.

William Tuceling reports that plans for the one day Seminar to be held at Vassar College on Sept. 16 are well underway and all committees are functioning according to schedule.

E. L. Leadbitter

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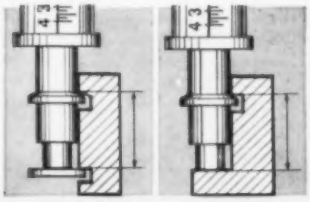

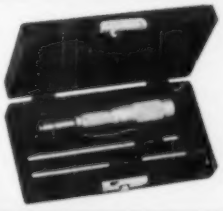

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MINNESOTA . . . May 16, final business meeting, Holiday Inn . . .

Bill Beck, retiring chairman, introduced the officers for the coming year, and committee chairmen made their annual reports. The entire membership joined in giving Bill and the outgoing officers a round of applause and congratulations on a successful year.

The only sad note of the night was the announcement that we must look for a new meeting place. It is hoped that it can be more centrally located and that we can retain the services of the caterers who have served us so well this year.

So ended the 1960-61 season, with the remainder of the evening spent in social activities.

Violet M. Rice

MONTREAL . . . May 10, joint meeting with the Institute of Radio Engineers . . . Topic—"The Mechanics of Reliability" by Allen Oxley, reliability coordinator, Canadair Ltd. . . .

Mr. Oxley began his talk by describing in detail the type of knowledge and the kind of background required by persons interested in working in the field of reliability. He then gave an excellent exposition—with the aid of some very informative slides—of the methods used to solve a great number of the problems occurring in industry.

The showing of a film edited by H. F. Eppenstein, chief of reliability, Convair (Astronautics) Division, General Dynamics Corp., brought a very instructive evening to a close. The film, entitled "Locked On" shows how the Missile topic is related to reliability and emphasizes the necessity for every member of the "team" to do his very best to make each project a success.

The film also accentuates the importance of personal integrity in achieving a high degree of reliability.

J. J. Fitzsimons

GREATER MUSKEGON . . . May 19, 103 members of the quality control, production control, personnel and safety groups enjoyed a wonderful meal consisting of stuffed cornish hen and all the trimmings at the Occidental Hotel . . . Guest speaker Glen Massman, Glen Massman Enterprises, made a presentation on "Fear" . . .

May 23, the education committee met for a luncheon at Bill Sterns to formulate the 1961-62 program . . . Our basic and intermediate courses will be lengthened one week each as a result of a survey of the 1960-61 group of students . . .

During the summer months several meetings are scheduled dealing with our first Seminar at the Occidental Hotel, Sept. 30, 1961.

William A. Hume

NEW HAVEN . . . May 18, 32 members of the principles of measurements and gaging course sponsored by the New Haven section were awarded certificates . . . The 12-week course was conducted by W. Dowling, QC manager, MITE Corp., one night a week . . .

Sixteen different industries from Southern Connecticut were represented in the class. As part of the program, Joseph Panczak, assistant quality control manager, MITE Corp., and section publicity chairman, arranged a plant visitation and social at MITE prior to the presentation.

Section officers, including Henry Pianka, chairman; Lud Short, secretary, and Jack Gillies, advisor, participated in the presentation of certificates.

William L. Dowling

NORTHEAST TENNESSEE . . . May 9, Hotel Bristol, Bristol, Va. . . . Dr. Hubert Hill, Tennessee Eastman, spoke at the pre-session clinic on "Reliability and Quality Control" . . .

The guest speaker of the evening, Chester Gadzinski, consultant for quality control management, Raytheon Co., Waltham, Mass., gave an interesting and highly practical talk on "Planning for Incoming Material Control." The meeting was enjoyed by 30 members and 22 guests.

Mike Gomez

OMAHA-LINCOLN . . . May 12, Town and Country Motel, Lincoln, Nebr. . . . Dr. John Birch, professor of mathematics, University of Nebraska, spoke on "Operations Research" . . .

T. C. Anker

ORANGE EMPIRE . . . May 18, Waterwheel Restaurant, Anaheim, Calif. . . . Ed Steinmeyer, former vice chairman and the new chairman of this section introduced Kenneth W. Davidson, chief of reliability studies and environmental testing at the Semiconductor Division, Texas Instrument . . .

Mr. Davidson presented slides to augment his talk on Automatic Testing Equipment used for testing the various electronic components at the Texas facility. The topic proved very interesting and educational and was well received by the 57 members and guests.

Henry W. McKee

PARKERSBURG . . . May 17, Ladies' Night and Annual Dinner Meeting, Blennerhossett Room, Chancellor Hotel . . . The 42 members and guests present included plant managers and their wives from Union Insulating, Johns-Manville, American Viscose and E. I. Du Pont de Nemours & Co., Inc. . . .

After dinner Dr. Hillenbrandt of Ohio University treated the group to a showing of color slides of his and Mrs. Hillenbrandt's recent World tour. While on tour he visited some manufacturing plants in several countries and was very optimistic as to the quality of their products. The group was enthusiastic in appreciation for Dr. Hillenbrandt's effort.

Mr. and Mrs. Keith Lewis of Hudson, Mich., visited this section for the meeting. Mr. Lewis, Region 8 representative, recounted Society progress for the past year.

Robert R. Stewart

PHILADELPHIA . . . Your reporter had the pleasure of meeting many of the Society officers at the 15th Annual Convention and Exhibit in the Quaker City. While assisting Tom Moran, publicity chairman for the Convention Committee, I received a bird's eye view of the many details of planning that are necessary to make a convention successful. We are sure that general chairman Jules Mehalek and his committee will receive proper recognition is this issue of *IQC*.

The first executive meeting of the new section officers was held May 17 to discuss the Sixth Annual Symposium to be held sometime in September at the Pennslyvania State University, Ogontz Campus. Arnold K. Dodds, Signal Corps Supply Agency, was named chairman and will select his committee members. Further information will be provided through a section mailing.

Albert G. Dettore

PITTSFIELD . . . May 17, our May meeting was a follow-up of the previous month's meeting . . . Guest speakers were J. L. Bolster and W. M. McCallum . . .

Mr. Bolster initiated and directed the activities involved in planning, construction and selection of equipment for the new Metrology Laboratory at Pittsfield, Ordnance Department, General Electric Co.

Mr. McCallum came to this country from Scotland eight years ago. Since then he has been associated with General Electric Company.

He initiated and developed a Gauge Laboratory and Tool Inspection Unit for the Air Conditioning Department and has contributed to the development of the new Metrology Laboratory.

Both gentlemen, besides being very good speakers, gave very informative talks on the formation-construction and equipment of the Lab. Following their talks, we had two movies, "Optical Tooling" and "The Fifth Echelon Accuracy."

Graduates of the intermediate QC course were presented diplomas at this meeting.

May 31, first formal meeting of a new group sponsored by the Pittsfield section . . . This group is made up of

On May 13, the Portland section held a one-day workshop at the Portland Sheraton Hotel. From the left, Herman Karlebach, Portland section chairman; Colonel Walter Hurd, district representative, and Dr. J. M. Juran who conducted the management workshop.

Engineers involved with electronics, components and assemblies . . . 100 present—a tribute indeed to the work of the committee . . .

Guest speaker S. A. Yingling, manager of quality control development laboratory in Manufacturing Services, Schenectady, N. Y., gave a very fine talk on what the engineer can do to make Quality Control better and the relationship between QC and the engineer. He also showed some slides and told us about unusual test equipment.

Howard J. Greenslet

PORTLAND . . . May 13, 200 persons attended our conference conducted by Dr. J. M. Juran at the Sheraton Hotel . . . Chairman Casey Hoekstra has been thanked by the section . . . Jim Abel, Ruth Jones, Pat Keyes, Ray Vanderzanden and George Mickel assisted Chairman Hoekstra in making the conference a success . . .

Officers for the coming year are Casey Hoekstra, chairman; James Abell, vice chairman; George Mickel, treasurer; Helen Frierson, secretary; and directors—Herman Karlebach, Donald Hancock and Henry Blood.

Committee chairmen for the coming year are Henry Blood, program; Ruth Jones, membership; Ray Vanderzanden, education; Elizabeth Allison, arrangements; Mel Thompson, publicity.

Chairman Hoekstra is planning a new committee, section development, which will be responsible for the Saddoris Award activity.

George Mickel

RHODE ISLAND . . . The section was privileged once again to share in the sponsorship, through the New England Quality Control Conference, of the Advanced Statistical Institute at the University of Connecticut.

R. Shaw Goldthwaite, a director, ASQC, was the toastmaster at the graduation banquet on May 5.

Earlier that same week Mr. Goldthwaite was the keynote speaker at a seminar on precision for reliability in Providence. R. I.

Dr. A. W. (Bill) Wortham, executive director, ASQC, gave a "shirt sleeve" talk to the section on "Planning and Experimental Design." He emphasized the need for placing as much effort into corporate plans—both long and short range—as a well designed experiment. He challenged the group to recognize future problems facing the achievement of their organization's goals and to consider using quality control techniques in testing the validity of the planned solutions.

Paul K. Moffat

ST. PETERSBURG-TAMPA . . . The May meeting was held at the St. Petersburg Jr. College Faculty Dining Room. Approximately 45 members and guests attended the panel discussion on "Total Quality Control." Coffee and doughnuts were served after the meeting.

H. Goldbery

SEATTLE . . . May 20, All Day Conference, General Engineering Bldg., University of Washington . . . The theme—"The Quality Control Team" . . .

Several thought-provoking papers and lectures were given during the morning session. Kenneth Marsden, chief inspector, Canadian Pacific Airlines, gave a paper on "Inspection" covering the maintenance procedures for his company.

J. Gordon Siddons, chief of QC Laboratories, Aero-Space Division, Boeing Aircraft Corp., used color slides of their various labs and test procedures which covered ultrasonic testing, eddy currents, and back-scatter gauges. He also mentioned tests underway on the 80 types of bacteria found in jet fuels.

Leo E. Morris, chief mathematical statistician, USN Torpedo Station, Keyport, N.J., made the observation—"Statistics are the answer to the human error in judgement."

Leslie W. Ball, director of reliability, Aero-Space Division, Boeing Airplane Co., seemed to truly inspire and instruct with his lecture on "Reliability." He stressed the minute detail in all phases of operation, especially in the production area, as of greatest importance.

He gave a sample equation for the probability of failure: P_o (occurrence) $\times$ P_e (escape) $\times$ P_s (strength) $\times$ P_u (use) $= P_f$. If we evaluate the percent in each it gives us the extent to which we can equate. Since it is the human element which must be handled, and since there would be no probability of failure if all things were in perfect ratio, then we have the means of controlling people through observing, analyzing and generalizing.

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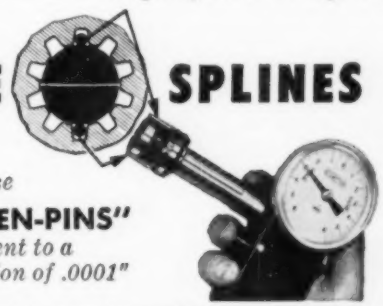

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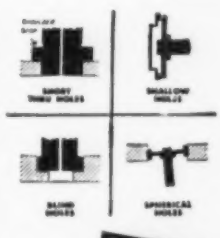

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The importance of analyzing was illustrated by the fact that failure to put a cap on a connector could be the cause of an electronic unit failure.

Facts are garnered through technician, inspection and lead personnel who are responsible for disciplining these actions.

Teaching of the individual includes the motivation of instruction, curricular and memory documents and bench documents such as check lists.

The sympathetic supervision of research and the great importance of paper work, which is a basic form of communication from research to application, lies under the plan of generalization. The feed-back from problems determines procedures and the surveillance use of check lists gives us vital information.

Failure on the production floor is responsibility for failure in action; from it follows that our responsibility is in basically controlling people through these processes.

James R. Killen, QC section, General Electric Co., gave a paper on "Manufacturing and Process Control," in which he stressed that process control is the co-ordinator which offers a continuing feed-back to determine the quality plan.

"Procedures" was the subject of John A. J. Filchak, chief of Research and Testing Branch of the QC Division, General Services Administration, at the Sand Point Naval Air Station.

Harold K. Hovland, vice president, Industrial X-Ray Engineers, was the luncheon speaker and covered "Non-Destructive Testing in QC," which ran the gamut from gear shafts to sesame seeds.

In the afternoon session, discussion groups covered the subjects presented during the morning session. The six groups—inspection, QC laboratories, statistics, manufacturing and process control procedures and reliability were moderated by the morning speakers.

May 9, Leo Heizenker, chief metallurgist, Seattle plant, Bethlehem Steel Co., conducted members on a tour of his plant, the largest mill in the Pacific Northwest—an outgrowth of a rolling mill built in 1895 at Lakeview, Washington. . . .

The plant was moved during 1905 to the present site under the name of Seattle Steel Co. Bethlehem acquired the Seattle Steel Company during 1930 and completely modernized the plant in 1958. Electric arc furnaces replaced the old open-hearth units, a blooming mill and soaking pit were built, a new Merchant Ball mill was installed, and the structural plant mill was modernized. Today, Bethlehem's Seattle plant is an efficient and well-balanced steel mill.

Dan Lillis

SOUTH TEXAS . . . Jerry Moyer will be chairman of the Chemical Division, ASQC, for this coming year.

Ed Franklin

SOUTHERN CONNECTICUT . . . May 10, Annual Management Night Banquet, Rose Room, Stratfield Hotel, Bridgeport, Conn. . . .

SECTION CALENDAR

Lima

Aug. 13, Lima Ordnance Picnic Grounds, 2-8 p.m., Annual Family Picnic for Lima section members and families

Orange

Aug. 1, Waterwheel Restaurant, 7 p.m., "Quality Problems Facing a Newly Formed Company" by William Hurst

Portland

Sept. 12, Oregonian Hostess House, 7:30 p.m.

Toledo

Sept. 7, EST Club Rooms, 8 p.m., "Economics of Quality Control" moderated by Don Anthony, Owens-Corning Fiberglass

Guest speaker, Leete P. Doty, assistant general manager of operations, Sikorsky Aircraft, presented "A New Look at Management Opportunities and Responsibilities." This meeting culminated an extremely successful year of programs.

Our section was well represented at the 15th Annual Convention and Exposition in Philadelphia, Pa. Jack Kidwell and Howard Rosenberg, Lycoming Division, Avco; Theodore Reuter, Bryant Electric Co.; Isidore Levine, CBS Laboratories; Frank A. Walsh and Alexander Vince, Dictaphone Corp.; Howard Levenson, Norden Division, United Aircraft Corp., and Thomas Ragona, Sikorsky Aircraft, attended the June Convention.

William E. Wells

TOLEDO . . . May 13, annual outing at the M & S Manufacturing Company cottage at Devils Lake, Mich. . . . Keith Lewis of M & S and Margaret Tobin were co-chairmen. . . . Everyone enjoyed the day and the charcoal broiled steaks . . .

Officers installed during the short business meeting are chairman—Margaret A. Tobin, Textileather Division, General Tire and Rubber Co.; vice chairman—James C. Clark, Permaglass, Inc.; secretary—Mrs. Beatrice M. Dorn, Doehler-Jarvis Division, National Lead Co.; treasurer—E. Stanley Melick, Brush Beryilium Co.; and directors—Hilton C. Fetting, Libbey-Owens-Ford Glass Co.; John R. Meeker, Johns-Manville Fiber Glass Inc.; Wayne A. Raab, Dura Corp.

Committee chairmen are program—Mr. Clark; conference—Theodore E. Meyer, Kimble Glass Co.; professionalism—Henry K. Gensler, Johns-Manville; membership—Paul E. Smith, Doehler-Jarvis; Saddoris Award and publicity—Roland E. Rockwell, Owens-Corning Fiberglass; arrangements—Hilton C. Fetting; social—Mr. Raab; historian—Nelson G. Meagley, Continental Aviation and Engineering Corp.; constitution—Melvin E. Lindner, Owens-Illinois Co.; Toulouse Award—Joseph A. Ivan, Johns-Manville, and Qualiteer—Robert Passino, Textileather. Toledo Technical Council delegates—Mr. Meagley and Mrs. Dorn, alternates—David A. Hettel, Johnson-Ruth Machinery Company and Miss Tobin.

Carwin L. Elwick

TRENTON . . . Harry Kleinkauf, QC engineer, Frenchtown Porcelain Co., Frenchtown, N.J., gave a very interesting talk on "Quality Control and Case Histories in Ceramics."

Mr. Kleinkauf, section treasurer, has presented numerous papers to the Society over the past years. To culminate his years of experience in the field of quality control, he is pursuing his masters degree in applied statistics at Rutgers • The State University, New Brunswick, N.J.

His talk revealed insights to quality control techniques in the ceramic field.

Julius S. Mazakis

WASHINGTON, D.C. . . . May 17, Tom Budne—substituting quite adequately for Dr. Harry Romig—gave a very instructive talk on the control of quality and reliability . . .

Mr. Budne pointed out that in some frames of reference, reliability may be thought of in two parts—statistical and non-statistical.

Statistical methodology is available to solve all industrial problems, yet this great body of techniques is not utilized completely, especially in selling programs to management.

It was noted that reliable products are products of evolution from the standpoint of "feedback" from consumers and engineers. This, however, does not hold true in certain industries, such as the automotive industry.

Eugene Tucker

WESTERN MASSACHUSETTS . . . May 9, Robert A. Tust, QC engineer, Western Electric Co., Inc., Allentown, Pa., presented "The Practical Application of Designed Experiments on Manufacturing Processes" . . .

Mr. Tust has been with Western Electric since 1957,

and as a member of the Allentown-Bethlehem section, ASQC, has served as membership chairman, assistant treasurer, and is the current nominee for treasurer for the 1961-62 season. Included in his presentation were actual case studies developed at Western Electric Co.

Richard Sheetz, plant manager, and Ed Hart, QC manager, Westinghouse Corp., East Springfield Works, co-hosted the meeting.

May 17, the executive board held a dinner and meeting at Storrowtown Inn, West Springfield, Mass. Committee reports covering the immediate past season, and plans for the 1961-62 season, were the order of business for the evening.

Alan J. Donnelly

Significant Differences

. . . ALLENTOWN-BETHLEHEM—A section sponsored eight week course on sampling inspection was concluded May 1. Instructor **Bob Tust** graduated eleven persons. Incidentally, Mr. Tust spoke to the Western Massachusetts section at West Springfield, Mass., May 9, on "Graphical Analysis of Experimental Designs."

Bernard Durant, QC engineer, Allentown plant, Western Electric Co., began a nine-week course of graduate engineering training in the Coliseum Bldg., New York City, May 8.

. . . COLUMBUS — **Charles McDermott,** Robertshaw Fulton Co., Hillsboro, Ohio, has been promoted from quality manager to manager of manufacturing engineering.

. . . HARRISBURG—**H. A. Gross,** RCA, Lancaster, Pa., will be the new section chairman. He will be assisted by vice chairman—**O. Fox,** Borg-Warner; secretary—**J. T. Fasnacht,** Hamilton Watch Co., and treasurer—**R. E. Lehman,** Carlisle Tire and Rubber Co.

Mr. Gross has appointed the following committee chairmen: publicity—**J. Walbrecht,** Raybestos-Manhattan, Manheim; membership—**D. C. Conner,** Hamilton Watch Co., Lancaster; program—**I. J. Bentzel,** Borg-Warner, York, and *IQC* reporter—**A. C. Englehart,** RCA Lancaster.

The new officers are busy formulating 1961-62 activities. Good luck!

. . . STATE UNIVERSITY OF IOWA—Our vice chairman elect, **M. F. Wilson,** has found it necessary to resign due to his transfer to Collins Radio Co., Dallas, Texas. To fill this vacancy, the following appointments have been made: vice chairman—**P. F. Cahalan,** resident inspector of Navy Material, Cedar Rapids, and secretary-treasurer—**E. D. Stambaugh,** Collins Radio Co., Cedar Rapids.

. . . LOS ANGELES—**E. J. Lancaster** has been elected as a vice president, ASQC. Mr. Lancaster, 1960-61 chairman of the Los Angeles section, has been with the Air Force QC operation for more than 20 years.

. . . METROPOLITAN—**George Lecky,** technical director, Corrugated Container Division, St. Regis Paper Co., New York City, was recently retired with the rank of Lieutenant Colonel in the U.S. Army Reserve.

. . . MINNESOTA—**Corrine Leko** of Minnesota Mining and Manufacturing Co., who has been secretary in the New Products Division, is transferring back to the technical computer department with the hope of soon returning to the technical field. Corrine was a QC clerk at Twin Cities Arsenal and at the 3M Company before entering the secretarial field. Welcome back, Corrine!

. . . MONTREAL—The following people have agreed to serve on the Forum Committee for the 1961 All Day Quality Control Forum to be held at Ecole Polytechnique, Oct. 28, 1961: chairman—**Miss Isobel Loutit,** Northern Electric Co., Ltd.; vice chairman—**Donald E. Schroeder,** Imperial Tobacco of Canada Ltd.; arrangements—**Roger Lessard,** Ecole Polytechnique; Brochure—**David W. S. Riddell,** Montreal Lithographing Co.; Program—**Peter Merchant,** Canadair Ltd.; publicity—**Brian L. Fenoulhet,** Canadian Copper Refiners Ltd.; registration—**Denys A. Pilon,** Canada Packers Ltd., and *Proceedings*—**Donald A. MacDonald,** Barrett Co. Ltd.

. . . NORTHEAST TENNESSEE—New committee chairmen are **Richard Hill,** education; **Ken Fraley,** program; **Mike Gomez,** publicity; **John Daly,** membership; **Joe Moriority,** professional development, and **Bill Townsend,** service.

Joe Johnston, past section chairman, will become chairman of the board of directors.

Jerry Hudson, Raytheon, Bristol, has been promoted to supervisor, incoming materials.

James Harr Raytheon, Bristol, now has quality review assigned to his responsibility in quality assurance.

W. H. Townsend has been promoted to section head in the quality control department.

The section was represented at the Convention by **Bill Morgan,** Sperry Farragut, and **Hubert Hill, Ralph Debusk, Tom Odom,** and **Robert Beard** of Tennessee Eastman Co.

J. T. Johnston section chairman, will present the Raytheon Science award to the outstanding science student at Douglas High School, Bristol, Va.

Dr. Hubert Hill attended a seminar in May with the Chemical Department of the University of Tennessee.

. . . ORANGE—**Peter Graham,** formerly QC director at Consolidated Printed Circuits, is now QC director at Delru Printed Circuit Co., Anaheim, Calif.

Charles Kleppsattel, the new vice chairman of this section, has been appointed head of the QC department on Diode Operations at Hughes Semiconductor Division, Hughes Aircraft Co.

. . . PARKERSBURG—Incoming officers for the 1961-62 season are chairman—**Edmund H. Albrecht,** E. I. Du Pont de Nemours & Co., Inc.; vice chairman—**Leon W. Maurer,** American Viscose; secretary—**Roy I. Buckley,** Union Insulating, and treasurer—**Robert O. McAtee,** Marion Chemical. Committee appointments will be announced at a later date.

. . . SACRAMENTO—One of our newest members, **L. E. Zwissler,** has been promoted to division manager of Aerojet's Polaris Reliability and Quality Control Division.

. . . SOUTH TEXAS—**Sanford Swasey,** past membership chairman of the South Texas section, is retiring and has moved to the hill country of Central Texas.

. . . SOUTHERN CONNECTICUT—Section member **J. Condie,** Lycoming Laboratory Supervisor, has recently completed a course in Linear Measurements at Metrolonics school in Burbank, Calif. This course was instructed by **John A. Harrington,** senior member, ASQC.

. . . TOLEDO—After being elected vice chairman, **Roy C. Settergren** was obliged to resign. General Mills, Inc., is moving Mr. Settergren and his family to Monroe, N.C.

Nelson C. Meagley was the recipient of the 1961 Toulouse Award presented by the section for outstanding accomplishment in the field of statistical quality control and service to the Society. Mr. Meagley, Fellow, ASQC, and first chairman of the Toledo section, was chairman of Toledo's first conference in April of this year. The Toulouse Award is presented in honor of **Dr. Julian H. Toulouse,** Fellow, ASQC, and member of the Toledo section. Congratulations, Mr. Meagley!

clinics, conferences, and courses

. . . **31-Aug. 11**—Statistical Methods in Industry series of seven concurrent courses at the University of California, Los Angeles, Calif. Courses are QC by statistical methods; industrial statistical methods; statistical design and analysis of industrial experiments; probability and statistics of reliability; engineering and management of reliability; basic measurements and standards, and fundamental principles of non-destructive testing. Contact Edward P. Coleman, Professor of Engineering, University of California, Los Angeles 24, Calif.

AUGUST

. . . **6-18**—Fourth Annual Institute on Missile Technology, University of Connecticut, Storrs, Conn., contact Albert L. Jeffers, Box U-56, University of Connecticut, Storrs, Conn.

. . . **14-25**—Special course on the science of precise measurement, Center for Measurement Science, George Washington University, Washington, D. C. The course will program a full schedule of classes from 8:30 a.m. to 4:15 p.m. daily. Subjects to be covered include "Design of Experiments" and "Time Frequency Measurements." Contact the Center for Measurement Science, George Washington University, Washington, D. C.

. . . **21-31**—Basic QC Course, University of Michigan, Ann Arbor, Mich., contact C. C. Craig, Statistical and Computing Laboratory, 106 Rackham Bldg., University of Michigan, Ann Arbor, Michigan.

. . . **28-Sept. 1**—International Heat Transfer Conference, Boulder, Colorado, contact American Society of Mechanical Engineers, meetings department, 29 W. 39th St., New York 18, New York.

. . . **29-Sept. 1**—66th Summer Meeting of the American Mathematical Society at Oklahoma State University, Stillwater, Okla., contact American Mathematical Society, 190 Hope St., Providence 6, R. I.

SEPTEMBER

. . . **5-15**—Statistical Methods and Advanced QC Course, Irving W. Burr, instructor, Purdue University, Lafayette, Ind., contact Statistical Laboratory, Engineering Administration Bldg., Purdue University, Lafayette, Indiana.

. . . **6-8**—Joint Nuclear Instrumentation Symposium sponsored by ISA, AIEE, and IRE, at North Carolina State College, Raleigh, N. C. Contact ISA Meetings Manager, Penn Sheraton Hotel, 530 William Penn Place, Pittsburgh 19, Pa.

. . . **9—Thirteenth Annual All Day Conference sponsored by Rutgers - The State University and the Metropolitan section, ASQC, at the Rutgers campus, New Brunswick, N. J. The program will have items of interest for all members of the quality control team and will include six concurrent sessions on applications of statistics in the ceramic, mechanical, chemical, and electronic industries plus two panels on administrative applications of statistics in the fields of auditing and accounting. "Quality Control and Statistics in Industry" includes basic and advanced topics of interest to members of the industrial, governmental and business communities. Contact Reginald Johnson, QC Manager, Eastern Surgical Dressing Plant, Johnson & Johnson, Route 1, North Brunswick, N. J.**

. . . **10-22**—Twelfth Annual Statistical Quality Control Institute, University of Connecticut, Storrs, Conn., contact Theodore A. Toedt, coordinator, University of Connecticut, Storrs, Conn.

. . . **11-15**—16th Annual ISA Instrument-Automation Conference, Biltmore Hotel, Los Angeles, Calif. Contact ISA Meetings Manager, Penn Sheraton Hotel, 530 William Penn Place, Pittsburgh 19, Pa.

. . . **12—Eighth Annual Bay Area Quality Control Conference, Stanford University, Palo Alto, Calif. Contact W. Grant Ireson, Head, Industrial Engineering Department, Stanford University, Palo Alto, Calif.**

. . . **14-15**—Ninth Annual Joint Societies Engineering Management Conference, Hotel Roosevelt, New York City. Contact IRE, 1 East 79th St., New York 21, N. Y.

. . . **15-16—ASQC-TAPPI short course in Evolutionary Operation at the Schine Inn, Chicopee, Mass. This course is being conducted in response to widespread interest in two other sessions held earlier this year. As before, the course will be given by Dr. J. Stuart Hunter, member of the Statistical Staff, University of Wisconsin, and Truman L. Koehler, head, Statistical Analysis section, American Cyanamid Co., Bound Brook, N. J. Evolutionary Operation (EVOP) is a method of operating a process in such a way as to produce on-specification product while simultaneously generating statistical information on how to improve the process (reduce costs, upgrade product quality, increase quality). Contact Miss A. Scott, TAPPI, 360 Lexington Ave., New York 17, N.Y.**

. . . **15-16**—Special two-day course in Experimental Design for Industry on Fractional Factorial Experimentation sponsored by the Extended Services Division of Rochester Institute of Technology, Rochester, N. Y. Course sessions will be held at the Country Squire Motel, Rochester, with the opening session at 8:30 a.m. on Friday, Sept. 15. Instructors will be Cuthbert Daniel and John D. Hromi. The course is specifically designed for industrial experimenters and statistical practitioners with a good understanding of the use and meaning of simple statistical analysis and tests of significance. Contact Extended Services Division, Rochester Institute of Technology, Rochester 8, N. Y.

. . . **16—One Day Seminar, Vassar College, 9 a.m., sponsored by the Mid-Hudson section, ASQC, contact E. L. Leadbitter, Dept. 301, Bldg. 002-3, International Business Machines, Poughkeepsie, N. Y.**

. . . **16—16th Michigan Quality Control Forum, Angel Hall, University of Michigan, Ann Arbor, Mich. Contact Dale A. Cue, Hoover Ball and Bearing Co., 5400 South State Road, Ann Arbor, Mich.**

. . . **16—The Scope of Quality Control, Granata Hotel, San Antonio, Texas, sponsored by the San Antonio section, ASQC, contact Robert W. Worrick, 239 E. Ackard Pl., San Antonio 21, Texas.**

. . . **18-20**—Tenth Annual Meeting, Standards Engineers Society, Hotel Sherman, Chicago, Ill. Theme—Standards = Cost Reduction. Contact J. E. Stevens, Chicago Bridge & Iron Co., 1305 W. 105 St., Chicago 43, Ill.

. . . **19-20**—Registration for two-semester credit courses, September 1961 through May 1962, at the Carnegie Institute of Technology. Courses cover probability and mathematical statistics, experimental design, and quality control and industrial statistics, and will meet one evening a week, 7:30-10:30 p.m., Wednesday, Thursday, and Friday evenings, respectively. Registration Sept. 19-20 from 6:30-9 p.m. For further information regarding graduate and undergraduate day courses, contact Professor Edwin G. Olds, Department of Mathematics, Carnegie Institute of Technology, Pittsburgh 13, Pa.

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POSITIONS AVAILABLE

Sr. Quality Control Engineers 5 to 10 years experience with BS degree required. Must be able to review customer specs; plan and implement quality procedures and methods as related to heavy machining, welding, and motor winding operations. Send confidential resume to J. Baker, Westinghouse Atomic Equipment Department, Cheswick, Pa.

. . . **21-22**—Industrial Electronics Symposium, Bradford Hotel, Boston, Mass., sponsored jointly by the AIEE, ISA, and the Professional Group on Industrial Electronics of the IRE. Contact D. J. LaCerda, Badger Manufacturing Co., 363 Third St., Cambridge, Mass.

. . . **22—Fall Symposium on Packaging and Packing Materials at Lowell Technological Institute, Lowell, Mass., sponsored by the Merrimack Valley section, ASQC. Contact Fred E. Ryan, QC Engineer, The National Co., Malden, Mass.**

. . . **26—One Day Quality Assurance educational program, at the Sheraton Motor Inn, Springfield, Mass., sponsored by the Western Massachusetts section, ASQC. The program is designed as a service to companies involved in government contract work who either need orientation in quality assurance requirements or have had persistent problems in fulfilling these requirements to government satisfaction. This program should be of interest not only to people concerned with government contracts, but also to those interested in introducing quality assurance into their own companies. The program will consist of five one-hour sessions beginning at 2 p.m.; dinner at 5:30 p.m., with sessions resuming at 7 p.m. and concluding at 9 p.m. Contact Alan Donnelly, Bigelow-Sanford Carpet Co., Thompsonville, Conn.**

. . . **28-29—Two-day QC Training Program, University of Chicago, downtown campus, Chicago, Ill., contact J. C. Dittrich, Victor Adding Machine Co., 3900 N. Rockwell St., Chicago 18, Ill.**

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. . . **28-30—ASQC Chemical Division Conference, Hotel Daniel Boone, Charleston, W. Va., contact Jack L. Massau, E. I. du Pont de Nemours and Co., P. O. Box 993, Charleston 24, W. Va.**

. . . **30—All Day Clinic on Quality Control sponsored by the Greater Muskegon section, ASQC, at the Occidental Hotel. Contact Merrill S. Bailey, Anaconda Wire and Cable Co., Muskegon, Mich.**

OCTOBER

. . . **2**—Community College Courses in Industrial Quality Control, an adult education, noncredit program offered by State College, Indiana, Pa. An eight week course in statistical quality control will start Oct. 2. A seven week course in management of quality control will start Oct. 6. The courses will meet one night a week from 6:45 to 9 p.m. Instructor—Edward A. Reynolds, Quality Control Consultant, Ligonier, Pa. Contact Dr. I. L. Stright, State College, Indiana, Pa. Plan definite enrollment not later than Sept. 11.

. . . **4-6**—Semi-Annual Convention, American Society of Photogrammetry, Biltmore Hotel, New York City. Contact Timothy Trott, Aeroflex Corp., 34-06 Skillman Ave., Long Island City, N. Y.

. . . **6-7—Intensive Short Course in Reliability sponsored by the Lima section, ASQC. Harmon S. Bayer, Quality Control Consultant, Detroit, Mich., will be the instructor. Contact D. C. Fultz, Lima Engine Plant, Ford Motor Co., Lima, Ohio.**

. . . **9-11**—National Electronics Conference, International Amphitheatre, Chicago, Ill. Sponsors include the American Institute of Electrical Engineers, Illinois Institute of Technology, Institute of Radio Engineers, Northwestern University, and the University of Illinois. Participants are Electronic Industries Association, the Society of Motion Picture and Television Engineers, Iowa State University, Marquette University, Michigan State University, Purdue University, University of Michigan, University of Notre Dame, University of Wisconsin, and Wayne State University. Contact NEC, 228 N. LaSalle St., Chicago 1, Ill.

. . . **10-12**—12th National Conference on Standards, Rice Hotel, Houston, Texas. Contact American Standards Association, 10 E. 40th St., New York 16, N. Y.

. . . **12-14—Three day short course on the Evaluation and Interpretation of Physical and Chemical Testing Methods at the Red Lobster Restaurant-Kenton Manor Motel, Tonawanda, New York. It will be sponsored by the Chemical Division, ASQC, and the Buffalo section, ASQC. Course instructors will be John Mandel, a member of the Testing and Specifications section at the National Bureau of Standards, and Grant Wernimont, Eastman Kodak Co., a pioneer in the study of accuracy and precision of testing methods. The course will be of value to laboratory personnel of all industries who have little or no experience in the statistical treatment of test data and evaluation of test methods. No experience in statistics is required. Contact James E. Dillman, chairman, Chemical Division Lab Course, Hooker Chemical Corp., P. O. Box 344, Niagara Falls, N. Y.**

. . . **15-19**—17th International Instrument-Automation Conference, Coliseum, New York City. Contact Instrument Society of America, 313 Sixth Ave., Pittsburgh 22, Pa.

. . . **20**—Second New York Conference on Electronic Reliability scheduled by the Metropolitan Chapter of the IRE Professional Group on Reliability and Quality Control at New York University, College of Engineering, University Heights, will be under the joint sponsorship of the New York, Long Island, and Northern New Jersey sections of the IRE. Theme—"System Reliability Engineering." Advance registrations, with a check in the amount of five dollars payable to the New York Conference on Electronic Reliability, may be sent to M. A. Benanti, Molecular Electronics Co., New Rochelle, N. Y.

. . . **22-25**—Fall Meeting of the National Fluid Power Association, Sheraton Hotel, Philadelphia, Pa. Contact National Fluid Power Association, 5595 N. Hollywood Ave., Milwaukee, Wis.

. . . **23-27**—43rd National Metal Congress, Cobo Hall, Detroit, presented by American Society for Metals and eight participating organizations. Contact T. C. DuMond, ASM, Metals Park (Novelty), Ohio.

. . . **24-25—Product Maintainability Working Seminar, Sheraton Hotel, Philadelphia, Pa., sponsored by the Electronics Division, ASQC. Contact B. W. Marguglio, Martin Co., Mail No. 2000, Baltimore 3, Md.**

. . . **25**—One Day Conference on Inspection of Steam Power and Nuclear Power Plant Components sponsored by the Utilities Committee,

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Society for Nondestructive Testing at COBO Convention Hall, Detroit, Mich. Contact Utilities Committee, Society for Nondestructive Testing, 1109 Hinman Avenue, Evanston, Ill.

. . . 25-27—15th New England Quality Control Conference, Statler Hilton Hotel, Hartford, Conn. Contact the registration chairman—John A. Sigmann, R. T. Vanderbilt Co., Inc., East Norwalk, Conn.

. . . 25-28—Electronics Division Meeting and 14th Pacific Coast Regional Meeting, American Ceramic Society, at the Jack Tar Hotel, San Francisco, Calif. Contact A. Cer. Soc., 4055 North High St., Columbus 14, Ohio.

. . . 26-27—Annual Quality Control Conference, University of Alabama, Tuscaloosa, Ala. Contact E. T. Finnell, Jr., Engineering Extension Services, University of Alabama, Tuscaloosa, Ala.

. . . 28—All Day Quality Control Forum at Ecole Polytechnique sponsored by the Montreal section, ASQC. Contact Denys A. Pilon, Quality Control Chemist, Canada Packers Ltd., 1260 Mill Street, Montreal, Quebec, Canada.

NOVEMBER

. . . 9-10—Eleventh Annual Conference of the Aircraft and Missile Division, ASQC, Ambassador Hotel, Los Angeles, Calif., theme—Assuring Customer Satisfaction, four concurrent series of sessions on international and general interest, design—reliability, production—quality control, and field service—maintainability. Contact Hardy Harris, publicity chairman, c/o North American Aviation, Inc., International Airport, Los Angeles 45, Calif.

JANUARY

. . . 9-11—Eighth National Symposium on Reliability and Quality Control, Statler-Hilton Hotel, Washington, D. C., sponsored by ASQC, IRE, EIA and AIEE. Contact A. R. Park, Mail Stop 729, Westinghouse Electric Corp., P. O. Box 1897, Baltimore 3, Md.

. . . 30-Feb. 2—18th Annual Technical Conference, Society of Plastics Engineers, Penn-Sheraton Hotel, Pittsburgh, Pa. Contact SPE, 65 Prospect Street, Stamford, Conn.

FEBRUARY

. . . 18-22—47th Annual Meeting, Technical Association of the Pulp and Paper Industry, Commodore Hotel, New York City. Contact TAPPI, 360 Lexington Ave., New York 17, N.Y.

MARCH

. . . 5-9—Thirteenth Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy sponsored by the Analytical Chemistry Group of the Pittsburgh Section of the American Chemical Society and the Spectroscopy Society of Pittsburgh. It will be held at the Penn-Sheraton Hotel, Pittsburgh, Pa. The absolute deadline for receipt of abstracts for papers is Oct. 16, 1961. For paper requirements and conference information, contact Dr. C. F. Glick, program chairman, The Pittsburgh Conference, Applied Research Laboratory, United States Steel Corp., Monroeville, Pa.

. . . 29-30—Conference, Administrative Applications Division, ASQC, at the Ecole Polytechnique, University of Montreal, Montreal, Quebec, Canada. Contact J. B. Pringle, Bell Telephone Company of Canada, 1050 Beaver Hall Hill, Montreal 1, Quebec, Canada.

ASQC Annual Convention

Future Dates

May 23-25, 1962	**Cincinnati**
May 20-22, 1963	**Chicago**
May 4-8, 1964	**Buffalo**
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June 1-3, 1966	**New York**

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Responsibility of the American Society for Quality Control, Inc., for Consulting Services advertising is limited to certification that advertisers hold the grade of membership in the Society stated in their advertisements. Qualification requirements for the several grades of memberships are set forth in the Constitution of the Society. Business card ads are available only to members of the Society—12 insertions $100.00; 6 insertions $65.00.

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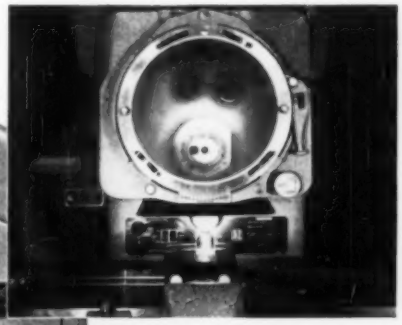

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